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Notes on the Black Army Cutworm, *Actebia fennica* (Tausch.) (Lepidoptera: Phalaenidae), a Pest of Low-Bush Blueberry in New Brunswick¹

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The black army cutworm, *Actebia fennica* (Tausch.), is the most important pest of foliage of the low-bush blueberry in New Brunswick. Although usually of minor importance, it periodically appears in outbreak proportions and destroys the entire crop in heavily infested fields. Such an outbreak occurred in Charlotte County in 1944 and 1945, when the present study was initiated.

The data presented in this paper are based on insectary-reared material, supplemented where possible by field observations. Larvae were reared individually in jelly jars or waxed cardboard cups and fed daily on fresh blueberry foliage. Observations on oviposition were made possible by mating reared moths.

Distribution and Importance

The black army cutworm is widely distributed in Canada (Gibson, 1915) and the northern United States (Phipps, 1927), and has been recorded in Siberia (Pospelova, 1935), Scandinavia (Aurivillius, 1888-1891, pp. 121-122), and Switzerland (Staudinger and Rebel, 1901). The larvae feed on a wide variety of plants and there are numerous records of injury (Caesar and Ross, 1926; Zappe, 1926; Knutson, 1944; Neilson, 1953). A list of food plants was given by Phipps (1927).

The species was first reported as a pest of blueberry in the State of Maine. Phipps (1927) stated that during an outbreak in 1924-25 damage occurred throughout the blueberry-producing section of the state and that losses were "tremendous". A second outbreak in 1944-45 caused considerable damage in Maine and also in Charlotte County, New Brunswick (Maxwell, 1950). By the spring of 1946 populations had been greatly reduced by natural control factors, and with only minor fluctuations have since remained at a relatively low level. The blueberry industry, however, has undergone considerable expansion in Eastern Canada during the last ten years and the potential loss from future outbreaks has correspondingly increased.

Descriptions of Immature Stages

When laid, the egg is creamy white and appears circular dorsally and ellipsoidal laterally, with dorsoventral striations. It has a diameter of 0.7 mm. and a height of 0.6 mm. During the incubation period it darkens in colour, becoming almost black before hatching.

Immediately after hatching, the larva is greyish-black with a black head capsule. After the first moult the larva is brown with a narrow, mid-dorsal white stripe and two similar white stripes on each side. The head capsule is brownish-black. After the second moult the general body colour is black, the dorsum being velvety black. In the ultimate instar the general colours are brownish-black on the dorsum, black on the sides, and greyish on the venter. On each side of the body is a narrow, white subdorsal stripe and a wider white spiracular stripe. The head capsule is golden brown except for the clypeus, which is brownish-black. Full-grown larvae are about 35 mm. long.

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The pupa is approximately 16 mm. in length, 5 mm. in width, and light brown in colour. The cremaster bears a pair of terminal spines.

Descriptions of the adult have been published by Gibson (1915) and Phipps (1927).

Life-History and Habits

There is one generation of *A. fennica* a year in New Brunswick. Larvae first appear about the middle of April under normal conditions, having overwintered in the soil in either the first or second instar. They feed at first on the blueberry buds and later on the blossoms and foliage. Although the greatest amount of damage is that from the feeding on the buds, the injury often escapes detection at this time. The larvae feed on the interior of the bud and leave the outer bud scales intact, so that the injury is very inconspicuous. Subsequent defoliation, however, becomes very obvious. Feeding is usually confined to the hours between dusk and dawn, the larvae spending the day in the litter layer or duff. Depletion of the food supply during outbreaks, however, forces the cutworms into the marching habit and under such conditions they may also feed during the day. Heaviest concentrations are usually found in first-crop fields (fields with plants that were burned in the previous year).

The larvae pass through six instars. Head capsule measurements for each instar were as follows:

Instar	I	II	III	IV	V	VI
No. measured	10	20	30	30	30	20
Range (mm.)	0.34- 0.37	0.51- 0.54	0.70- 0.90	1.02- 1.38	1.77- 2.16	2.42- 3.35
Mean (mm.)	0.36	0.52	0.82	1.23	1.97	2.94
Standard deviation	0.011	0.013	0.048	0.088	0.091	0.255

Larvae cease feeding six to ten days before pupating. Pupation takes place in the litter layer, beginning about the middle of June. Three to four weeks are spent in the pupal stage and adults begin to emerge during the latter part of July. The longest period recorded for the pupal stage in the insectary was 37 days and the shortest was 16. Records on pupation and emergence in the insectary from 1946 to 1951 are shown in Table I. The sex ratio of reared adults was approximately 1:1.

As the moths are not readily attracted to light or baits, little information was obtained on the flight period. However, a few specimens were collected

TABLE I
Durations of Pupation, Pupal, and Emergence Periods of *A. fennica*

Year	No. of pupae	Pupation	Pupa, days		Emergence
			Range	Mean	
1946.....	2	June 29	—	28	July 27
1947.....	17	June 25—July 2	—	—	July 20—28
1948.....	28	June 28—July 13	22—32	25.8	July 28—Aug. 5
1949.....	16	June 9—July 4	22—29	26.7	July 21—July 29
1950.....	22	June 13—July 4	29—37	32.2	July 20—Aug. 2
1951.....	7	June 20—July 9	24—34	29.0	July 26—Aug. 2
1952.....	9	June 17—July 5	—	—	—
1953.....	30	June 25—July 2	16—25	21.0	July 13—27
1954.....	15	June 23—July 6	28—31	29.8	July 24—29

TABLE II
Records of Parasitism from Insectary Rearings, 1946-1954

Year	No. of host larvae reared	No. of hosts parasitized		Percentage parasitized by all species
		by <i>A. canadensis</i>	by other species	
1946.....	328	243	—	74.1
1947.....	307	131	—	42.8
1948.....	350	141	—	40.3
1949.....	194	97	1	50.5
1950.....	192	125	—	65.1
1951.....	205	43	—	21.0
1952.....	338	23	2	7.4
1953.....	1,634	156	14	10.4
1954.....	549	77	—	14.0

between August 11 and September 5. Pospelova (1935) states that in Siberia a definite flight period occurs during July.

Reared moths were induced to mate by placing them in an 18-in. x 18-in. screen cage kept in the insectary. Absorbent cotton moistened with sugared water provided the moths with food. Mating did not take place until the second week of confinement. The females were then removed and placed individually in jelly jars containing about one inch of loose duff. Oviposition began within two days after mating and sometimes continued as long as 28 days. The eggs were laid singly or in clusters below the surface of the duff. The maximum number of eggs laid by an insectary-reared moth was 421 and the mean was 161. In confinement all moths died either before their total complement of eggs had been laid or within a week after oviposition ended. The maximum longevity of adults in confinement was six weeks. The eggs hatched about the middle of October, after an incubation period of 58-78 days.

Apparently the larvae do very little feeding in the fall and were not collected in the field until the following spring. The first moult occurs either shortly before they hibernate or immediately after they emerge from the soil in the spring. In the insectary first-instar larvae did a limited amount of feeding until early in November, accepting both blueberry and lambkill (*Kalmia angustifolium* Ait.) as food. All the insectary specimens hibernated in the first instar.

Natural Mortality

Four species of primary parasites were reared from larvae of *A. femica* collected in the field. Determinations were made by officers of the Entomology Division, Ottawa, as follows: Ichneumonidae, Mr. G. S. Walley; Braconidae, Dr. W. R. M. Mason; Pteromalidae, Dr. O. Peck; Diptera, Mr. G. E. Shewell.

Larvae of *Arenetra canadensis* Cress. (Hymenoptera: Ichneumonidae) emerge from full-grown host larvae from early June to early July. They pupate within three days after leaving the host and remain in the pupal stage until the latter part of the following April. The hyperparasite *Dibrachys caryus* (Wlkr.) (Hymenoptera: Pteromalidae) has been reared from pupae of *A. canadensis*.

Adults of *Poecilanthrax tegminipennis* (Say) (Diptera: Bombyliidae) emerge from the pupae of *A. femica* in August. Larvae of *Nepiera marginata* (Prov.) (Hymenoptera: Ichneumonidae) emerge from partly grown larvae early in May, pupate almost immediately, and emerge as adults one week later. Specimens of

Rogas sp. (Hymenoptera: Braconidae) pupate within full-grown larvae in May or early June and emerge as adults 13-31 days later.

The relative effects of these parasites on populations of *A. fennica* are shown in Table II.

Occasionally larvae of *A. fennica* died from what appeared to be a fungus disease. The causal organism, however, was not identified.

Summary

The black army cutworm, *A. fennica*, is an important pest of the low-bush blueberry in New Brunswick; it is usually a minor pest but causes considerable damage periodically.

There is one generation a year in New Brunswick. The larvae overwinter in the soil in either the first or the second instar. They emerge about the middle of April to feed at first on blueberry buds and later on the blossoms and foliage. Pupation occurs during the latter part of June and adults emerge three to four weeks later. The eggs are laid in the duff early in August and hatch in October, after an incubation period of 57-58 days. The larvae do very little feeding in the fall and hibernate on the approach of cold weather in November.

Four species of primary parasites were reared from the larvae.

Acknowledgment

The writers appreciate the many helpful suggestions of Mr. C. W. Maxwell, Officer-in-Charge, Fruit Insect Section, Fredericton, under whose direction the work was carried out.

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Some Micro-organisms Associated with the Weevils *Sitophilus granarius* (L.) and *Sitophilus oryza* (L.), (Coleoptera)

II. Population differences of mycetomal micro-organisms in different strains of *S. granarius*

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Introduction

Certain kinds of micro-organisms occurring in close internal association with insects, and often harboured in apparently specialized organs, are, at least in some species, of benefit to the insects in supplying them with needed dietary constituents, e.g., vitamins of the B complex (3).

During the past twenty years conflicting statements have been made about the presence of mycetomal micro-organisms in *Sitophilus granarius* (6, 11). Recently some general clarification has been achieved (9). It seems that while this species commonly harbours such micro-organisms, there exists an Egyptian strain apparently free of them. Furthermore, a variety *africana*, distinguishable by its smaller size and lighter colour, has been described from the Nile Valley (1, 5).

We believe, therefore, that it is appropriate to report that we have found in Canada a strain of *Sitophilus granarius* apparently similar to the Egyptian strain and the variety *africana*.

Methods

The methods of preparation and examination were similar to those previously described (9): the gonads of female and the mesentera of male and female weevils were crushed and then examined by phase contrast microscopy, using an 8 mm. objective (x20) and a x8 ocular. Previous experience had shown that under these circumstances the long mycetomal micro-organisms apparently typical of the species, (9), could readily be seen, and, in making assessments, a preparation was classified as negative only after a careful search.

New Observations

Microbiological

Three strains of *Sitophilus granarius* have been investigated: GG, our standard strain; and MW and LG, which were obtained from Mr. H. A. U. Monro of the Science Service Laboratory, London, Canada.⁴ When preliminary examinations of the MW and LG strains failed to reveal the characteristic mycetomal micro-organisms, a more thorough survey was made during a period of several weeks. The results may be summarized as follows: Thirty-four insects of the MW strain examined in various stadia:—only 2 were positive, 1 was indeterminate and 30 negative. Forty-eight insects of the LG strain examined in various stadia:—only 2 were positive; 46 were negative.

Examinations of insects in the experiments to be described and other observations have confirmed these findings and permit the contention that the LG and MW strains are composed of weevils in which, though there may be small micro-organisms or micro-organism-like structures, the long mycetomal micro-organisms of the GG strain are rare or absent.

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³A portion of a thesis presented in October, 1955, to McMaster University in partial fulfilment of the requirement for the degree of Doctor of Philosophy.

⁴The significance of the code letters applied to the strains is as follows:

GG—Guelph *granarius*.

LG—London *granarius*—because from the Science Service Laboratory in London, Canada.

MW—Montreal wild—name given to this stock by Mr. H. A. U. Monro as it was derived from weevils collected in the Port of Montreal.

Under our standard nearly optimum conditions the adults of the MW strain were medium brown in colour and smaller than the dark brown specimens characteristic of the GG strain. Members of the LG strain were lighter in colour but about the same size as members of the GG strain.

Weights of Weevils

Richards (10) found that the weights of weevils of *S. granarius* were dependent upon factors of age, nutrition, individual rate of development, and general environmental conditions. Nonetheless, he was able to establish the separate, genetical existence of three weight strains in *S. granarius*: when reared under his standard conditions these had mean weights of 1.90, 2.07 and 2.46 mgm./weevil respectively.

Members of the strains GG, LG and MW were therefore weighed. Adult weevils, reared on whole wheat grains, under similar environmental conditions, were removed from cultures of comparable age and condition, and, in an effort to remove any personal bias, were randomized. The weevils were picked out of the cultures with forceps and placed in water in a petri dish to wash them. They were then removed to a paper towel to be blotted dry and then placed in a conical glass flask, appropriately stoppered, where they remained until required for weighing. They were subsequently obtained from the glass flask, at random, by tilting the flask, and accepting the required number of weevils, in order, as they walked up the glass towards the neck of the flask.

The results shown in Table I clearly indicate a highly significant difference in weight between strains MW and GG. This seemed to be general. For instance, weights of progeny in the crossing experiments described below were: progeny of the MW ♀, 2.08 mgm./weevil and progeny of the GG ♀, 2.90 mgm./weevil. Of course, weevils of any strain reared under unfavourable conditions weigh less than and may be paler than members of the same strain reared under nearly optimum conditions.

The LG and GG strains could not be distinguished by weight: but members of LG were significantly heavier than those of M.W.

Reciprocal Crosses

S. granarius cannot be sexed with certainty by morphological characteristics (10). Thus crosses could be effected only by a rather elaborate method of trial. Virgin weevils of the different strains were obtained by removing inhabited grains from cultures into complete or partial isolation in separate vials. Virginity was assured in those in partial isolation in two ways: (i) by removing them from their grains by dissection before they had emerged naturally, or (ii) by their natural emergence at different times.

TABLE I
Weights of Two Strains of *S. granarius*

Specimens weighed in groups of ten.

Figures given are means of weights of ten weevils in mgm./weevil.

Strain GG	Strain MW
2.57	2.00
2.48	2.27
2.80	2.16
3.00	2.08
2.70	2.05
2.71 mean	2.11

Significance test: — $t = 5.393$.

The difference between the means is therefore very significant.

These were weighed the 23 of November, 1954. The weevils had been removed from stock cultures of about the same kind, i.e. grain eaten to the same extent, and were derived from more than one culture for each strain.

Sometimes virginity could also be checked by dissection. The virgin weevils were confined together in pairs, two strains being represented in each pair, the member of one strain being marked with a small spot of white poster-paint on the thorax. The pairs were observed to see if mating occurred and thus to determine the sexes. If it seemed that, with any particular pair, mating was not going to occur, the individuals were removed and confined with different weevils in other vials. In this way some crosses were effected. Details are given below. Some of the progeny of these crosses were examined as adults, by the technique already described on page 97.

The many specimens that contained abundant characteristic mycetomal micro-organisms were easily recognised and classed as positive. Others were readily classed as negative. The assessment of specimens in which artifacts, spermtails, casually invading or other micro-organisms made decisions difficult, was resolved by classifying as negative any specimen in which not more than five clearly identifiable characteristic mycetomal micro-organisms were seen. The results were as follows:

Cross No. 1	MW ♀ x GG ♂
50 progeny examined:	
Positives	1
Negatives	46
Indeterminates	3
Cross No. 2	MW ♀ x GG ♂ (♂—virgin?)
13 progeny examined:	
Positives	0
Negatives	13
Cross No. 3	GG ♀ x LG ♂
42 progeny examined:	
Positives	42
Negatives	0

During the examination of the progeny of Cross No. 3, the original male was found marked with paint: it was examined and found to be negative.

These results clearly suggest that the mycetomal micro-organisms are inherited entirely through the female, and are absent from the reproductive system of the male (4, 9).

Discussion

Possibly, the present findings may help to explain Mansour's (7) conclusion about a micro-organism-free Egyptian strain of *S. granarius*, as microbiological investigations of the strains MW and LG could warrant a similar conclusion about them. Evidently, too, small-sized, light-coloured weevils of *S. granarius* are not confined to the variety *africana*, unless this variety has been imported into Canada from the Nile Valley.

Our findings may also facilitate detailed nutritional studies of the kind envisaged by Buchner (1) in discussing our earlier work (8).

The existence of several strains of *S. granarius* may explain the discrepancy in results obtained in pharmacological experiments on this and the related species, *S. oryza* (8, 12). But a more likely explanation is available. Musgrave and Miller (8) found that *S. oryza* was more adversely affected than *S. granarius* when fed grain treated with the antibiotic terramycin, whereas Steinhaus and Bell (12), who subsequently performed a similar experiment, claimed that the two species were equally adversely affected. Their findings must be viewed with caution since they compared bioassay results at a level of stimulus (dose)

that produced, in their experiments, 100% response, (mortality) in the compared organisms. Mortalities cannot be compared at the 100% level. This fact, universally accepted in modern bioassay work, is discussed briefly by Finney (2).

Summary and Conclusions

Sitophilus granarius occurs in Canada in different strains. When reared under standard nearly optimum conditions, one consists of dark brown weevils mostly harbouring characteristic mycetomal micro-organisms: two others consist of weevils paler in colour, in most of which the mycetomal micro-organisms characteristic of the other strain have been rarely found. These observations may help to account for the supposed existence of a micro-organism-free Egyptian variety.

One of the pale strains appears to be similar to variety *africana* of this species previously described from the Nile Valley.

Experimental work suggests that the mycetomal micro-organisms are inherited congenitally, and, only through the female.

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**New Species of *Psylla* from Western United States
and Biological Notes¹
(Homoptera: Psyllidae)**

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This paper presents descriptions of four new species of the genus *Psylla*, brief notes on their biology and records the encyrtid *Prionomitus mitratus* (Dalm.) as a parasite of *Psylla ribesiae* (Crawford). Of particular interest is the fact that two of the four new species occur on *Ribes* spp. and previously were not distinguished from the common species, *ribesiae*, which has been known in western United States since 1911.

***Psylla notapennis* Jensen, new species**

Figs. 1, 2, 3, 4, 5.

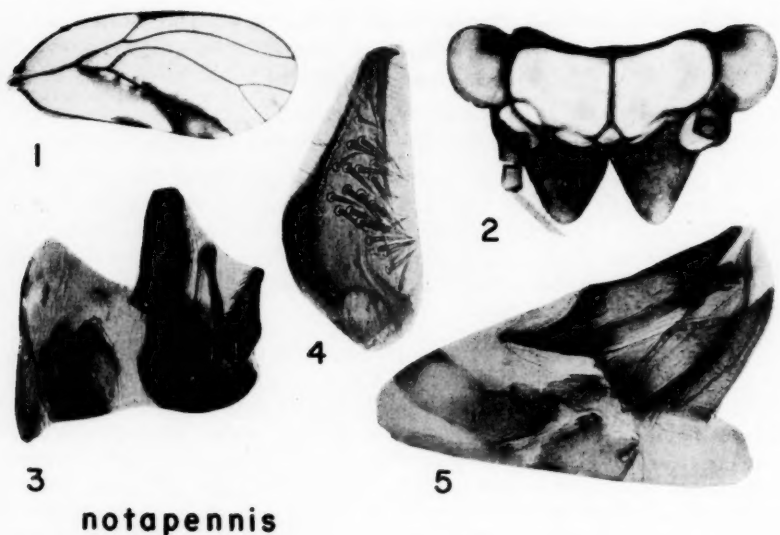
Color.—General color variable from light and dark brown variegation to uniformly reddish brown; antennae brown distally; vertex, pronotum and pre-scutum cream-colored to light brown with a few darker markings; genal processes usually darker than vertex; scutum dark brown with light markings; abdomen mottled light and dark brown; forewings hyaline with a dark brown area at tip of clavus, a brown macula covering the first marginal cell, becoming indistinct or disappearing as it extends along both sides of Cu to branching of media; three faint brown areas extending in from posterior margin of wing, one between each pair of veins from Cu to radial sector. Within each brown area occurs a slender patch of pointed setae; setiferous area in first marginal cell considerably larger than others.

Structure.—Length to tip of folded wings 3.9–4.4 mm.; length of forewing 3.3–3.7 mm.; width of head 0.94 mm.—1 mm.; length of antennae 2 mm. Head deflexed at 45 degree angle or greater; anterior margin of vertex broadly rounded, deeply emarginate around median ocellus at median suture which is 0.25–0.27 mm. long; vertex with a moderately deep discal fovea on each side of median suture near weakly carinate posterior margin; discal foveae connected across median suture by a narrow groove; genal processes subequal in length to, and extending almost on same plane as vertex, stout, approximately as thick basally as length, broadly to subacutely rounded at apex, divergent, pubescent. Thorax robust, strongly arched, punctate. Forewings about twice as long as broad, medial vein strongly arched toward radial sector; pterostigma moderately broad basally, less than half as long as radial sector.

Terminalia.—Male. Proctiger 0.35 mm. long; forceps 0.22 mm. long above ventral genital valve, 0.3 mm. in full length when dissected out; in lateral view sides subparallel, slightly narrowed and weakly curved caudad subapically, terminating in a blunt black apex with a small, beak-like tooth produced cephalad; in caudal view forceps moderately broad and flattened with posterolateral margin produced laterally in proximal third as a black, shiny, convex flange; meso-cephalic face of forceps with large setae. Female. Genital segment 0.7 mm. long, stout, about half as long as rest of abdomen; dorso-ventral thickness at base subequal to length; dorsal valve only slightly longer than ventral, apex subacutely rounded, dorsal and lateral surface of black, apical third with small, stout setae; apical fourth of ventral valve with stout, acute setae on dorsal margin.

Host.—*Ribes* spp.

¹The writer is indebted to Dr. E. S. Ross for making the collection of Psyllidae at the California Academy of Sciences available for study. The opportunity of making some of the collections listed was afforded by the U.S. Department of Agriculture during the writer's service in the Division of Fruit Insect Investigations.



Figs. 1-5 *Psylla notapennis* n. sp. 1. forewing; 2. head; 3. lateral view of male terminalia; 4. latero-cephalic view of male forceps; 5. lateral aspect of female terminalia.

Type locality.—Yorkville, Mendocino County, California.

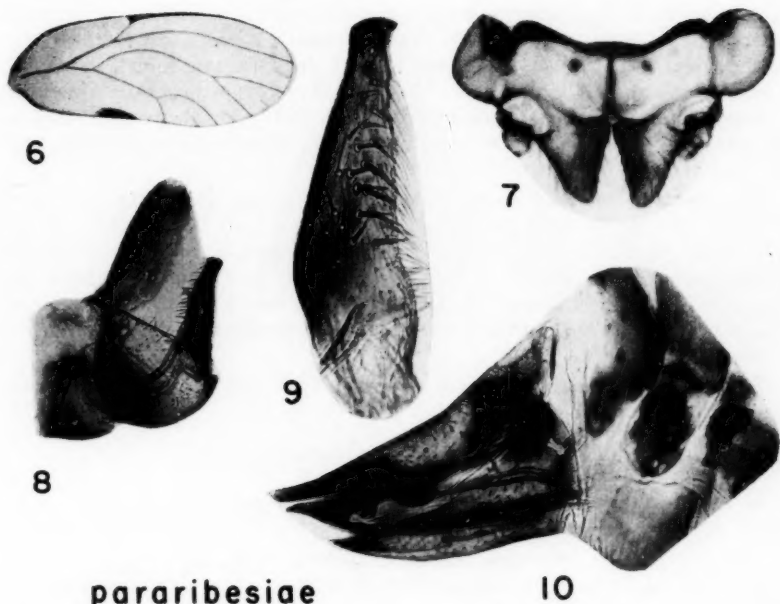
Holotype female (Mus. Ent. Calif. Acad. Sci.), *allotype* male (Mus. Ent. Calif. Acad. Sci.), and five paratypes, one male and four females, collected at Yorkville, Mendocino County, California, April 30, 1924 (E. P. Van Duzee). Additional paratypes, all from California, as follows: one male, Marsh Creek-Mt. Diablo, Contra Costa County, March 10, 1931 (E. P. Van Duzee); one female, labeled Tehachabi Pass, which probably was meant to be Tehachapi Pass, Kern County, June 6, 1929 (E. P. Van Duzee); one male from *Ribes hesperia*, Ojai, Ventura County, March 10, 1919 (E. O. Essig); one female and one male from *Ribes indocorum*, Santa Susana, Ventura County, February 9, 1919 (E. O. Essig). This species is nearest to *ribesiae* and *pararibesiae* as discussed under *ribesiae*.

***Psylla pararibesiae* Jensen, new species**

Figs. 6, 7, 8, 9, 10.

Color.—Vertex and genal processes cream-colored to light brown, antennae usually dark in distal half; pronotum mottled with light and dark brown; prescutum light over lateral and posterior portions, darker antero-medially; scutum cream-colored to light brown with orange tinge, a longitudinal, spindle-shaped dark brown stripe on each side of middle and two irregular dark markings laterad which usually converge at one point in anterior half of scutum; legs light brown; abdomen dark dorsally, light ventrally; forewings hyaline with dark area at tip of clavus and four dark linear marks, formed by small, acute setae, extending inward from wing margin between each pair of veins from first marginal cell to radial sector.

Structure.—Length to tip of folded wings 4.2-4.5 mm.; length of forewing 3.7-3.86 mm.; width of head 1 mm.; length of antennae 1.9 mm. *Head* deflexed at 45 degree angle or greater; anterior margin of vertex broadly rounded, deeply emarginate at median suture which is 0.25 mm. long; vertex raised



pararibesiae

10

Figs. 6-10. *Psylla pararibesiae* n. sp. 6, forewing; 7, head; 8, lateral view of male terminalia; 9, laterocephalic view of male forceps; 10, lateral aspect of female terminalia.

along each side of median suture to near posterior margin where a narrow groove connects deep discal foveae across median suture; genal processes 0.29 mm. long, stout, but distinctly longer than basal width, extending almost on same plane as vertex, weakly divergent, roundly acute apically, pubescent. *Thorax* robust, strongly arched, coarsely punctate. *Forewings* over two and one-half times as long as broad; pterostigma narrow.

Terminalia.—*Male*. Proctiger 0.45 mm. long; forceps 0.38 mm. full length when dissected out; in caudal view almost straight, curving gradually toward each other near apices; caudal face flat with angular margins, postero-lateral margin near base produced only slightly as a black ridge; in dorsal view apical portion of forceps produced somewhat mesad as a black, roundly truncate ridge, with an acute, beak-like tooth directed cephalad; antero-mesal face of forceps conspicuously pubescent. *Female*. Genital segment 1 mm. long, less than length of rest of abdomen; dorsal valve distinctly longer than ventral, moderately acute and slightly upturned apically; narrow apical fourth of dorsal valve with numerous short, cephalically pointed setae; ventral valve moderately setiferous distally.

Host.—*Ribes* spp.

Type locality.—San Ardo, Monterey County, California.

Holotype male (Mus. Ent. Calif. Acad. Sci.), *allotype* female (Mus. Ent. Calif. Acad. Sci.), 5 male and 12 female *paratypes* from *Ribes* sp., San Ardo, Monterey County, California, April 17, 1950 (D. D. Jensen). Additional *paratypes*: 4 females from same locality, March 24, 1931 (E. P. Van Duzee); 4 males and 6 females from Pleyto, Monterey County, California, May 21, 1920 (E. P. Van Duzee); one female from Bridgeport, Mono County, California,

July 8, 1934 (E. P. Van Duzee), 4 males and 4 females from *Ribes* sp., Huntsville, Weber County, Utah, June 21, 1939 (D. D. Jensen); 2 males and 2 females from same host and locality August 3, 1947 (D. D. Jensen); one female from *Ribes* sp., Morgan County, Utah, June 9, 1943 (D. D. Jensen); one male from *Ribes* sp., Austin, Lander County, Nevada, June 15, 1947 (D. D. Jensen); and one male and one female from *Ribes* sp., Ellensburg, Kittitas County, Washington, July 11, 1943 (D. D. Jensen).

This species has also been collected at Covina, Los Angeles County, California, March 27, 1948, February 25, April 8, April 22, and May 6, 1949 (R. C. Dickson and R. A. Flock) and from Cucamonga, San Bernardino County, California, April 8, 1949 (R. C. Dickson and R. A. Flock). Nymphs were collected with adults at Huntsville and Morgan, Utah; Ellensburg, Washington; and San Ardo, California. Adults were reared from nymphs, caged singly, from the latter two localities.

This species is related to *ribesiae* and *notapennis* but is readily distinguished from both as discussed under *ribesiae*.

***Psylla ribesiae* (Crawford)**

Figs. 11, 12, 13, 14, 15.

Psyllopa ribesiae Crawford, 1911.

Psylla gilletti Patch, 1912.

Arytaina ribesiae Crawford, 1914.

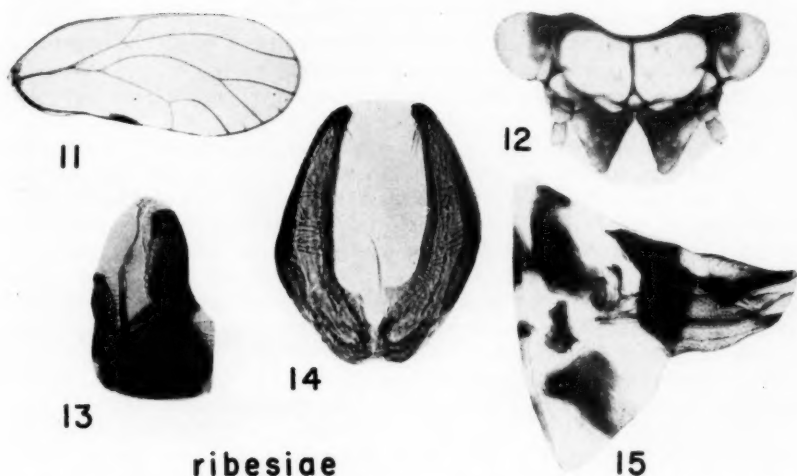
Psylla ribesiae Tuthill, 1943.

Of the three species of *Psylla* occurring on wild currant in Western United States, *ribesiae* is by far the most commonly encountered. Before *pararibesiae* and *notapennis* were recognized to be distinct species, the geographic range of *ribesiae* was reported to be Colorado, Kansas, Nebraska, South Dakota, Wyoming, Idaho, Utah, Arizona, California, and Oregon. The geographic range of *ribesiae*, as now defined, is not known. The type locality is in Colorado. Specimens from New Mexico, Utah, Idaho, Nevada and California have been examined during this study.

New records. NEW MEXICO: Nymphs and adults from wild currant, Espanola, Rio Arriba County, June 3, 1943 (D. D. Jensen). UTAH: Brigham, Box Elder County, April 20, 1938 (L. D. Christenson and D. W. Clancy); Provo, Utah County, October 22, 1938 (L. D. Christenson and D. W. Clancy); nymphs and adults from wild currant, Huntsville, Weber County, June 21, 1939 (D. D. Jensen); nymphs and adults from wild currant, Bountiful, Davis County, June 16, 1943 (D. D. Jensen); adults from *Salix* sp., Hurricane, Washington County, October 20, 1939 (L. D. Christenson and D. D. Jensen). NEVADA: Nymphs and adults from wild currant, Austin, Lander County, June 15, 1947 (D. D. Jensen). CALIFORNIA: Nymphs and adults from wild currant, San Ardo, Monterey County, April 17, 1950 (D. D. Jensen).

Parasites. Two nymphs collected at Espanola, New Mexico, on June 3, 1943, were parasitized. On June 20, 1943, one parasite had emerged and was lost. The parasite in the second nymph had become an adult and was moving within the shell of the psyllid nymph. However, the parasite died without emerging. It was dissected out and was identified as *Prionomitus mitratus* (Dalm.) by A. B. Gahan of the U.S. National Museum. This is the only parasite species recorded from psyllids in both the New World and Europe.

Taxonomy. *Psylla ribesiae*, *pararibesiae* and *notapennis* are related species but can be distinguished readily. *Psylla ribesiae* is conspicuously smaller than the other two species and differs from them in structural characters and in the



ribesiae

Figs. 11-15. *Psylla ribesiae* (Crawf.). 11, forewing; 12, head; 13, lateral view of male terminalia; 14, caudal aspect of male forceps; 15, lateral aspect of female terminalia.

wing pattern. The forewings of all three species have a dark macula at the tip of the clavus. The forewing of *pararibesiae* can be recognized by the four well defined dark linear marks, formed by small setae, extending inward from the wing margin between the veins and their branches. In *notapennis* a brown macula covers the first marginal cell and extends along the cubital vein. The male forceps differ in size and form, with those of *pararibesiae* being the longest and straightest; those of the other two species are approximately the same length but the forceps of *notapennis* are stouter than those of *ribesiae*. The female genitalia of *pararibesiae* are relatively more elongate than those of *ribesiae* and *notapennis*.

The nymphs of *notapennis* are unknown, but the nymphs of *ribesiae* and *pararibesiae* can be distinguished easily in all instars. In addition to being larger, the nymphs of *pararibesiae* can be detected by their dark brown color which results from heavy sclerotization. The nymphs of *ribesiae* are green to yellowish and are only lightly sclerotized.

Psylla ribesiae, *pararibesiae* and *notapennis* are three sympatric species which apparently have wild currant, *Ribes* spp. as their host plants. Collections of the first two species as nymphs and adults on wild currant establish their host relationship without any question. Adults of *notapennis* have been taken on *Ribes* spp. and the morphological relationships of *notapennis* to the other two species indicate that it probably also breeds on *Ribes*.

In several localities both nymphs and adults of *ribesiae* and *pararibesiae* have been collected together on the same wild currant bushes. The nymphs of *pararibesiae* usually occur on the woody stems of the plant whereas the nymphs of *ribesiae* typically feed on the under surface of the younger leaves and on the green fruits and their petioles.

Although distinct species, *ribesiae*, *pararibesiae* and *notapennis* are obviously related and probably evolved by geographic isolation. Subsequently they came together again and their geographic ranges now overlap, that of *pararibesiae*

and *ribesiae* extensively so. Since the psyllids are highly host specific it is probable the geographic isolation, which permitted these three species to evolve from an ancestral species on *Ribes*, occurred during a long period of time when the *Ribes* species must have been reduced from a general distribution to a few widely separated areas.

The host plant specificity of the Psyllidae applies primarily to the genera rather than the species of plants. Thus there seems to be no correlation between the number of plant species in the host genera and the number of psyllid species which breed on them. Among the host plant genera of the Psyllidae in North America, *Salix* has undergone the greatest speciation and serves as host for more species (Ca. 18) of *Psylla* than any other genus (Jensen, 1951). The genus *Ribes* is probably next to *Salix* in speciation and distribution, yet only three species are known to breed on this group of plants. All three are closely related and two are being described here for the first time. In contrast, *Cercocarpus* (mountain mahogany) has few species and limited distribution, but supports a large number of psyllid species in three different genera.

Distribution. At the present time, *notapennis* is a California species known from Ventura County, the Tehachapi Mountains of Kern County, Contra Costa County and Mendocino County. Its range overlaps that of *ribesiae* and *pararibesiae* from Ventura County to Monterey County.

In California, *pararibesiae* ranges from Monterey County south through Los Angeles County, into San Bernardino County and Mono County. It also occurs in Nevada, northern Utah and Washington. It should also be found in Idaho.

The geographic range of *ribesiae*, as now defined, is not known. In all localities where the writer has collected *pararibesiae*, the species *ribesiae* has also been present except at Ellensburg, Washington, where *pararibesiae* occurred alone. In contrast, *ribesiae* has been collected at several localities in the absence of *pararibesiae*. It is anticipated that *ribesiae* will be found to occur in most of the western states.

Both *ribesiae* and *pararibesiae* exist in the mild coastal region of southern California and also in the mountainous regions around the Great Basin.

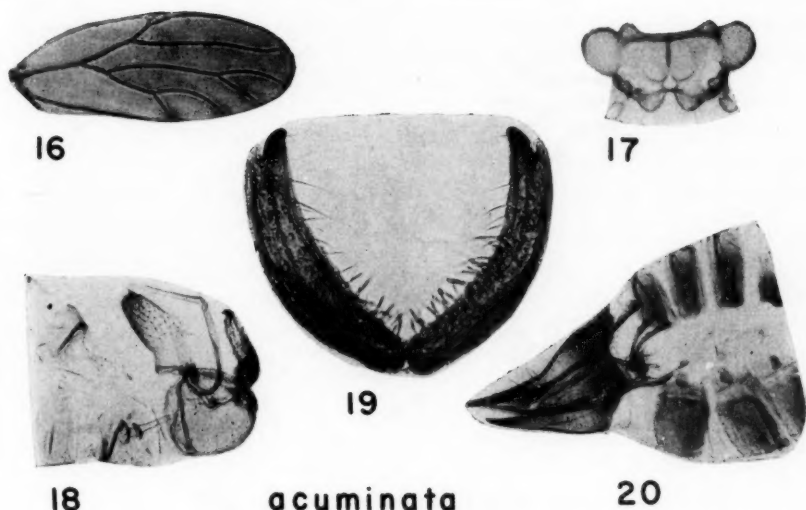
Psylla acuminata Jensen, new species

Figs. 16, 17, 18, 19, 20.

Color.—Males usually pale orange with light variegations on thoracic dorsum; females range from green with pale orange variegation to the same color as the males; antennae dark apically and on distal portion of other segments except basal two; forewings hyaline with inconspicuous fumate markings along media, cubitus and their branches.

Structure.—Length to tip of folded wings 2-2.3 mm.; length of body 1.7-2.2 mm.; length of forewing 1.6-1.8 mm.; width of head 0.5-0.56 mm.; length of antennae 1 mm. *Head* extending almost horizontally in life, becoming more or less deflexed in death; vertex 0.18 mm. long at median suture, bulging weakly in anterior portion on each side of, and emarginate at, median suture, moderately impressed discally on each side of raised median suture margins; postocellar areas elevated; genal processes short and depressed below level of vertex, 0.075 mm. long, basal width greater than length, not contiguous basally, divergent, roundly acute apically, pubescent. *Forewings* about two and one-half times as long as broad; pterostigma moderately broad basally, but short, no longer than distance to branching of radial sector.

Terminalia.—*Male.* Proctiger 0.25 mm. long, somewhat ovoid in shape from caudal view; forceps 0.23 mm. long above ventral genital valve, sides parallel



Figs. 16-20. *Psylla acuminata* n. sp. 16, forewing; 17, head; 18, lateral view of male terminalia; 19, caudal aspect of male forceps; 20, lateral aspect of female terminalia.

and moderately straight to near apex where forceps gently curve mesad and terminate in a short, black, weakly hooked tooth produced meso-cephalically from postero-mesal face of forceps; antero-lateral portion of forceps produced dorsad apically as a very small, fleshy process, reaching half way to apex of black tooth from which it is separated by a sharp emargination; forceps pubescent on inner face particularly in proximal half. *Female*. Genital segment, 0.45 mm. long, about half as long as rest of normally distended abdomen; dorsal valve a little longer than ventral, caudal half acuminate and covered with short, stout, setae directed cephalo-dorsad; ventral valve subacute apically and bearing short, stout setae over distal portion.

Host.—*Cercocarpus ledifolius* Nutt.

Type locality.—Macdoel, Siskiyou County, California.

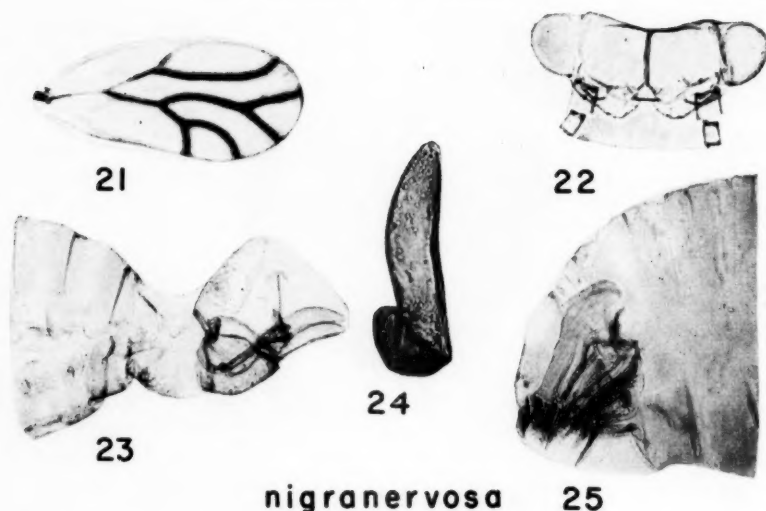
Holotype male (U.S. Nat. Mus.), *allotype* female (U.S. Nat. Mus.) and 25 paratypes collected on *Cercocarpus ledifolius*, Macdoel, Siskiyou County, California, November 7, 1941 (D. D. Jensen). Additional paratypes from same host and locality, October 9, 1942 (D. D. Jensen). Nymphs collected with adults in both instances are believed to be those of *P. acuminata*. They occurred on the leaves, and were not covered with any waxy floss or granules.

This species resembles *brevistigmata* superficially, but is quite distinct in the form of both the male and the female terminalia. The female genitalia resemble those of *difficilis* more than they do those of *brevistigmata*.

***Psylla nigranervosa* Jensen, new species**

Figs. 21, 22, 23, 24, 25.

Color.—General color of head and thorax red with orange tinge, vertex yellowish to yellow orange, thoracic dorsum with irregular yellowish variegation; abdomen dark red with female sternites dark brown and apical third of female genitalia black; antennae black in distal two-thirds, becoming pale brown basally;



nigranervosa 25

Figs. 21-25. *Psylla nigranervosa* n. sp. 21, forewing; 22, head; 23, lateral aspect of male terminalia; 24, male forcep; 25, lateral aspect of female terminalia.

forewings hyaline except veins which, distad from branching of R plus M plus Cu, are black with adjacent membranous area brown for a distance of vein width on each side of vein; marginal vein around entire wing, pterostigma, and R plus M plus Cu, before branching, white opaque to cream-colored.

Structure.—Length to tip of folded wings 2-2.3 mm.; length of body 1.6 mm.; length of forewing 1.6-1.9 mm.; width of head 0.7-0.8 mm.; length of antennae 1 mm. **Head** deflexed at about 45 degree angle, as wide as or slightly wider than thorax; eyes borne on short stalk-like base produced laterally from head; vertex 0.175-0.2 mm. long at median suture, a little more than twice as wide as length, postocellar areas strongly elevated, a discal fovea near posterior margin on each side of median suture with a shallow, broad sulcus widening out from fovea to antennal insertion; vertex strongly swollen on each side of median suture which is emarginate anteriorly; genal processes short, broadly rounded apically, depressed below level of vertex, scarcely visible from dorsal view, widely separated basally with frons easily visible between them in cephalic view; sparsely pubescent. **Forewings** a little over twice as long as wide; pterostigma very small, almost wanting.

Terminalia. Male. Proctiger stout, short, 0.26 mm. long, tapering evenly to rounded apex; forceps 0.2 mm. long above ventral genital valve; in lateral view moderately stout and tapering to simple, sub-acute apices; distal half curving mesad and caudad with anterior margin produced as a thin, black, narrow, gently curved or rolled ridge; from antero-mesal face of forceps near base a flat, truncate, black-rimmed, vertical flange is produced mesad. **Female.** Genital segment 0.4 mm. long, about half as long as rest of abdomen; dorsal valve strongly descending caudad, particularly over black apical third which is set off laterally by a gentle constriction or emargination; dorsal valve bears a tuft of white hairs midway on dorsal surface; ventral valve complex, consisting of a lateral lobe on each side extending caudad half the length of dorsal valve;

median portion modified to form a thin, flat, horizontal, opaque plate proximally which is narrowed in distal half as an elongate, tongue-shaped flange extending caudad three-fourths of the length of the dorsal valve.

Host.—Unknown.

Type locality.—Red Rock Canyon, Kern County, California.

Holotype male (Mus. Ent. Calif. Acad. Sci.), *allotype female* (Mus. Ent. Calif. Acad. Sci.), and six paratypes, one male and five females, collected at Red Rock Canyon, Kern County, California, May 17, 1937 (E. P. Van Duzee).

This species is conspicuously different from, but related to *Psylla phorodendrae* Tuthill. The male and female terminalia of both species are of the same unusual basic pattern but readily distinguishable, and the eyes are born on a stalk-like area which is smaller in the case of *P. nigranervosa*. They differ markedly, however, in size, coloration, wing form and pattern, and in the shape and position of the general processes.

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Dermatitis of Humans Caused by the Fowl Mite, *Dermanyssus gallinae* (Deg.), at London, Ontario

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In November, 1955 two women in a room in a private hospital in London, Ontario, were found to be affected by an irritating dermatitis distributed generally over the body. The causative agent was an infestation of mites which were found in the bedding, over the walls of the room and on furniture. Collections of the mites were made in the room on November 18, 19 and 20. They were also found clustered about a bruise on an apple in a bowl of fruit in the room. The mites were sent to Dr. E. W. Baker, United States National Museum, who kindly identified them as the fowl mite, *Dermanyssus gallinae* (Deg.). Some specimens were retained for the collection of the U.S. National Museum and others have been mounted on slides No. E23.95-98 in the collection of the Department of Zoology, University of Western Ontario.

The likely source of the infestation of mites in the room in the hospital was a person who served food on trays to the two women affected by the dermatitis and who was also the proprietor and operator of a chicken farm. Clinical data concerning this case were contributed by G. B. Sexton, M.D., London, Ontario.

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Observations on the Distribution of Grasshopper Egg-pods in Western Canadian Stubble Fields¹

By L. G. PUTNAM² AND N. SHKLOV³

The egg-laying habits of the pest species of grasshoppers in Western Canada have been known, in their essential characteristics, since the work of Criddle (1920). Methods used in routine surveys in the Prairie Provinces have been based on this knowledge since 1932, when surveys as they are now known were first made. For example, the habit of the principal pest species, *Melanoplus mexicanus mexicanus* (Sauss.), of distributing its egg-pods widely in fields of ripening or harvested small grains, and not in native grasslands or highly restricted, selected sites, was known. Likewise, the habit of another important grasshopper, *Cammula pellucida* (Scudd.), of concentrating its eggs in areas of native sod adjoining cultivated fields was recognized.

Some experienced surveyors knew, or strongly suspected, that egg-pods of *M. m. mexicanus* were not distributed in infested fields at random, but showed a tendency to be grouped, perhaps in a form of "contagious" distribution familiar in entomology. Davis and Wadley (1949), investigating some egg infestations of *M. m. mexicanus* in the United States, recognized the essence of this in their statement: "In practice, a departure from the random or Poisson condition occurs, population being 'bunched', and this departure is greater in dense infestations. In many sparse infestations the Poisson is nearly realized. In dense infestations variation is absolutely greater and proportionally less than in light ones".

The purpose of this paper is to elaborate on the nature and extent of the departure from the random distribution, to present a few data from the investigations of earlier workers that bear on the problem in the Prairie Provinces, and to describe the oviposition behaviour of *C. pellucida* when it departs from its "normal" habit and behaves as a stubble grasshopper.

General Methods

Most of the data that form the basis of this investigation were accumulated during routine sampling for egg-pods in a series of experiments on tillage for the control of grasshoppers. These experiments were conducted in fields that for the most part could be regarded as ecological units, even though some of them were divided into alternate fallow and cropped strips of narrow width. The fallow strips were kept free of vegetation by tillage throughout the summer. Such strips were frequented by grasshoppers to a limited extent for basking, but not for oviposition. Within any one field, the cropped strips had been sown to the same crops at nearly the same time and were generally handled alike. Plots were usually two to three acres in size; when they were laid out on narrow stubble strips, each plot extended the full width of the strip and thus had two borders adjoining fallow land, leaving an opportunity for border effect on two sides. This was true of all plots in the experiments at Swift Current, Sask., and at Milo, Alta. An experiment at Shaunavon, Sask., differed in design in that only one edge of most plots was exposed to border effect. In a solid (unstripped) field at Davidson, Sask., all plots were completely shielded from border effect. The sizes of the fields in the tillage experiments varied from about 65 to 160 acres.

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Soil sampling for egg-pods was not carried out on all plots; as a minimum, each of those plots left untilled as checks was sampled. The check plots were distributed so that their egg infestations should have afforded a satisfactory estimate of the general infestation.

Sampling was done at a standard rate of 50 one-square-foot units per plot. For simplicity of procedure, sampling points were distributed over the plot in 10 rows of five per row. The sampling points within a row were spaced at an interval equal to one-sixth of the plot width. At Swift Current and Shaunavon the first and last sampling points in each row were spaced at this interval from the plot boundaries, so that extreme marginal effect was excluded from these samples. Later, at Milo and Davidson, this practice was modified so that the first point in any row of five was situated from zero to twice the between-point interval from the plot margin. This was done to provide a greater element of randomness in sampling, and to allow for the inclusion of plot margins in the sampling scheme. Rows of sampling points were regularly spaced at intervals equal to one-eleventh of the length of the plot; the first and last rows were spaced at the same interval from the ends of the plots. Spacings between rows and between points within rows were established by pacing.

Each sample unit was taken in two one-half-square-foot portions, a spade with a 6-by-12-inch blade being used. The first spadeful was taken at the point where the worker's heel landed on the last pace of the interval, and the next at some fixed arbitrary distance, such as the length of the spade. The two halves were sifted together as one unit.

Sampling was always done in stubble fields, i.e., in fields that had been harvested but not as yet tilled. Where the stubble was in drill-rows, each spadeful of soil was taken so that a row of stubble 12 inches in length ran through the centre of the sub-unit. This was satisfactory with a spade six inches wide because the normal spacing between drill-rows is also six inches. The procedure is required because under at least some conditions grasshoppers oviposit among the subterranean portions of stems and roots of plants. Material adhering to the roots and stems was shaken off into the sieve before discarding the plants.

Wire-cloth sieves, usually of six meshes to the inch, were used for separating the egg-pods from the soil. Such sieves are fine enough to retain most pods and large pod fragments. However, the worker usually watched the accumulating soil beneath the sieve for whatever might pass through, usually single eggs from broken pods. Under more difficult conditions, such as very moist soil, four-mesh sieves were occasionally used; with these, there is a greater chance for pods to pass through the sieve, and the need for watchfulness became greater.

Data obtained by sampling 32 plots are presented and analysed. Twelve of the plots were infested about equally by *M. m. mexicanus* and *C. pellucida*. Eggs of the two species from these plots were recorded separately, making in effect a total of 44 samples. General information about the samples is presented in Table I. The information in Table I is bulked according to the locations of the fields from which the samples were drawn, but the material from the Davidson field, in addition to being subdivided according to the two species, is further divided according to two infestation levels. This was done in order to increase the range of infestation levels that could be statistically explored.

Observed vs. Random Distribution

The observed distributions deviated consistently from the Poisson, or random, distributions as follows. At all observed levels of infestation the number of sample units yielding no pods exceeded the theoretical number. Units containing

small numbers of pods, one, two, or more (depending on the level of the mean infestation), were fewer than expected, and those containing large numbers, such as three or more (again depending on the mean), were more numerous than expected. For example, the theoretical likelihood of finding 10 to 15 pods in any square-foot unit in Replicate III at Davidson was very small, yet such units constituted about two per cent of the sample, *M. m. mexicanus* and *C. pellucida* being considered separately. Some factor or factors must therefore cause ovipositing grasshoppers to favour some spots more than others, either expressly for egg-laying or for some other reason or reasons that result in an incidental concentration of egg-pods.

The percentages of the total egg-pods displaced from the lower to the higher frequency classes were as follows. In the bulked samples from Davidson (Replicates I & II), Shaunavon, and Swift Current, with average infestations of 0.54 to 1.06 pods per square foot, the percentage was from 14 to 16. However, in the Milo sample, with an average of 1.14 pods per square foot, the percentage was 32; at Davidson (Replicate III), the percentages for *C. pellucida* and *M. m. mexicanus*, each averaging nearly 1.45 pods per square foot, were respectively 38 and 41.

Observed Distribution in Relation to the Negative Binomial

In an attempt to describe the distribution in a more refined manner in the negative binomial $(q-p)^{-k}$, q being in this case equal to $1+p$. The chance of observing any positive count x is $f(x) = \binom{k+x-1}{x} \left(\frac{1+m}{k}\right)^{-k} \left(\frac{m}{m+k}\right)^x$, where the mathematical terms, resort was had to a contagious type of theoretical distribution, mean $m = pk$. Mathematically, this is less elegant than the Poisson, in that the exponent k is a variable that may differ for each organism and has to be separately estimated. By one of the processes described by Anscombe (1949), a value of k equal to 1.07 was derived from eight composite samples, bulked on the basis of fields (Table I). When the observed distributions of egg-pods in the sample from the various plots were fitted to the theoretical negative binomial distributions, the chi-square test for goodness of fit gave the following results:—

	<i>M. m.</i> <i>mexicanus</i>	<i>C.</i> <i>pellucida</i>
Total number of samples (one per plot).....	32	12
Distributions fitting with a probability of		
.05 or more.....	28	12
.01 - .049	3	0
less than .01	1	0

When the distributions of the eight composite samples from the various fields were fitted to the negative binomial, still retaining $k = 1.07$, the results were as follows:—

	<i>M. m.</i> <i>mexicanus</i>	<i>C.</i> <i>pellucida</i>
Total number of composite samples (one per field).....	6	2
Distributions fitting with a probability of		
.05 or more.....	2	2
.01 - .049	2	
less than .01	2	

The evidence for acceptable fit to $(q-p)^{-1.07}$ is more satisfactory for samples representing plots of only two or three acres than for those representing whole fields.

TABLE I
Summary of Statistical Information on Egg Samples according to Source, Year, and Species

Source of sample	Year	Species	No. of plots sampled	Av. pods per sq. ft. ($m \pm SE_m$) ¹	95% fiducial limits of mean
1. Davidson, Sask.; Repl. I & II	1950	<i>C. pellucida</i>	8	0.540 \pm .048	.427- .653
2. Davidson, Sask.; Repl. I & II	1950	<i>M. m. mexicanus</i>	8	.618 \pm .070	.453- .783
3. Shaunavon, Sask.	1945	<i>M. m. mexicanus</i>	6	.730 \pm .062	.571- .889
4. Swift Current, Sask.; "Sec. 20"	1944	<i>M. m. mexicanus</i>	5	.848 \pm .134	.476-1.220
5. Swift Current, Sask.; "Sec. 35"	1944	<i>M. m. mexicanus</i>	5	1.064 \pm .077	.832-1.260
6. Milo, Alta.	1947	<i>M. m. mexicanus</i>	4	1.140 \pm .115	.774-1.506
7. Davidson, Repl. III	1950	<i>M. m. mexicanus</i>	4	1.430 \pm .224	.717-2.143
8. Davidson, Repl. III	1950	<i>C. pellucida</i>	4	1.480 \pm .255	.669-2.291

¹Standard errors were computed from plot means.

The observed and theoretical distributions of the samples on the basis of fields are compared graphically in Fig. 1. Although the deviations of the observed distributions from the negative binomial are no doubt significant in the extreme cases, no predictable regularity in deviations occurred, and the general trend of the distributions conformed reasonably well to the negative binomial, which therefore is a useful description for egg-pod distribution of these species in stubble fields.

Egg-laying Habits of *C. pellucida* and *M. m. mexicanus*

At Davidson, where *C. pellucida* and *M. m. mexicanus* oviposited in the same stubble field, the shapes of the curves and ranges of the distributions, both at the lower and at the higher levels of infestation, were remarkably similar for the two species, indicating that each may have responded to similar situations in the same way. It was in fact observed during sampling that egg-pods of the two species in the same sample units tended to vary together in number. The correlation coefficient was .44, highly significant with 900 pairs of data. This correlation, although not strong, is high enough to be of ecological interest, in view of the small size of the sample units.

General Discussion

Macro-habitat Variations

In this study, significant differences sometimes occurred between infestations in different plots within the same field. Field observation suggested a number of factors that might contribute to large-scale variations in infestations.

Food Supply and Exposure.—When sampling on gently rolling terrain, the senior author has sometimes observed that slopes facing northward, away from the sun's rays, were distinctly less favoured for oviposition than those having surfaces upon which the incident rays of the sun may be more nearly at right angles for part of the day. This is to be expected in latitudes in which grasshoppers must often depend upon insolation for enough warmth to carry on life processes.

The heaviest concentration of *M. mexicanus* eggs ever observed by the senior author was around the perimeter of a rather small, low-lying spot in a field of wheat. At the regular seeding time this had remained saturated with run-off water from the melting of snow. At a relatively late date, when it became sufficiently dry, it was sown to oats. This crop therefore remained green after the surrounding wheat had become ripe and unappetizing, and attracted the

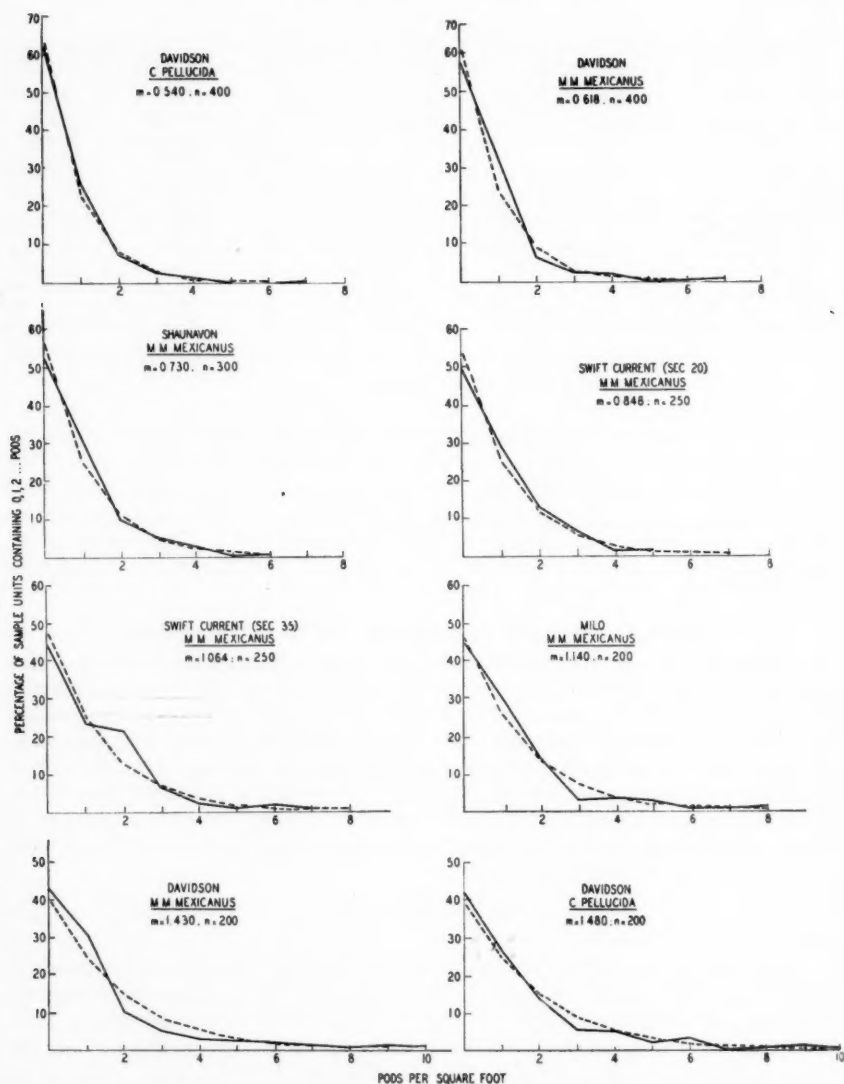


Fig. 1. Fits of the negative binomial $(q-p)^{-1.07}$ (broken lines) to observed (solid lines) intra-field distributions of egg-pods of two species of grasshoppers.

ovipositing grasshoppers, resulting in the observed concentration of eggs. This type of habitat is rather common in the Prairie Provinces, where much of whatever drainage that takes place is internal, but it by no means follows that numerous eggs of *M. m. mexicanus* may always be found in such places when the species is abundant. On the contrary, if food supply over the general area of the fields is not a limiting factor at the time of egg-laying, such low spots or non-perennial sloughs may repel grasshoppers because of excessive shade from

the density of vegetation standing upon them. For example, at Davidson, Replicate III had an average infestation more than double that on the remainder of the experimental area. It was evident on inspection that Replicate III was slightly higher in elevation, sandier, and less densely vegetated than the remainder. The favourable factor here, affecting *M. m. mexicanus* and *C. pellucida* alike, seemed to have been the opportunity to bask in comparatively open vegetation. On the one hand, food as a factor limiting adult distribution can result in non-random distribution, perhaps in a low-lying area; on the other hand, conditions favourable for warmth on high ground may favour concentration there. The result is dependent upon how weather and moisture supply affect plant growth.

Marginal Effect.—Another gross aspect of the habitat that may affect concentration is marginal effect. The procedure for routine egg surveys in the Prairie Provinces provides for this, giving any marginal concentration extra weight by placing three of the five sampling points for the field within 20 yards of the margin of the field being sampled. Analyses of results of such sampling have shown that sometimes concentration toward the margin takes place, but not invariably.

Davis and Wadley (1949) found no marginal effect, and stated as a general principle that "... sampling within the field need not follow an exact pattern that gives fixed representation to parts near the centre and edge". Dr. R. Glen (unpublished), in a study of egg-pod distribution in a stubble-field near Swift Current, Sask., found no concentration of egg-pods toward the outer edges of the field. Again, Dr. L. C. Paul (unpublished), in an analysis of five-unit samples taken in 1938 from each of 133 fields in central Saskatchewan, found very little distinct evidence of greater abundance in the outer two or three sample units. On the other hand, in a comprehensive study of egg infestations found during the autumn surveys of 1941, 1942, and 1943 in Saskatchewan, Dr. Paul found significant evidence of a marginal effect in egg-laying. If the egg-pods had been distributed at random, 60 per cent would have been found in the outer three sample units; in the three consecutive years, 69, 85, and 79 per cent were found in this portion of the samples. In 1943, the marginal concentration was marked in some districts, absent in others, the marginal effect being associated with very heavy crops, left standing until late in the fall; heavy vegetative cover and cool weather are thought to have limited the penetration of adult grasshoppers to the margins of the crops.

Egg infestations in the period 1941-43, although great enough for significant observations, were relatively low. When grasshoppers are abundant, conditions for crop growth are often incidentally poor to mediocre, so that grasshoppers are able to bask in desired warmth anywhere in an infested field. Such conditions usually prevailed at the times and places during which the samples analysed by the present authors were taken. Also, in the present work, the sampling scheme did not consistently represent the margins of the areas sampled.

Micro-habitat Variations

Variations in height and density of crops and sometimes weeds on a local scale might favour some concentration of breeding adults. Even after the crop has been harvested, some sessile, bushy weeds, and variations in stubble density on a very local scale, might influence grasshoppers to favour spots as small as one square foot or less in extent. *M. bivittatus* (Say) is known to grasshopper surveyors to be extremely sensitive to local variations within its favourite habitat, roadside ditches, and *M. m. mexicanus* may exhibit an analogous but less extreme

tendency in its habitat. Usually the elements in the micro-habitat that cause selection or rejection do not seem obvious, but one worker, Dr. R. H. Handford, (1956) demonstrated that by selective instead of random sampling he could at least double the number of *M. m. mexicanus* egg-pods found. According to his description, the attributes of favoured sites were subtle, such as a skip of a few inches in an adjacent drill-row, resulting in an improvement of exposure. Such irregularities in plant stand are, of course, very common in stubble fields.

Summary

The distribution of grasshopper egg-pods in stubble fields was investigated using data obtained by intensive sampling of 32 plots, all infested with *Melanoplus mexicanus mexicanus* (Sauss.). Twelve of these were about equally infested with *Cammula pellucida* (Scudd.), making 44 samples in all. The plots were distributed among five fields, one of which was divided according to the two species and two infestation levels. The infestation per plot varied from 0.34 to 2.24 pods per square foot. The following results were noted:—

1. The number of sample units containing numerous pods was larger than expected on the basis of random deposition, indicating selectivity or incidental aggregation on the part of the ovipositing adults.

2. Observed distributions were fitted to a form of contagious distribution, the negative binomial $(q-p)^{-k}$, a derived value of k equal to 1.07 being used. Of the 44 distributions within plots, 40 fitted the negative binomial with chi-square values giving probabilities greater than .05. When the samples from the various plots were bulked into eight composite samples from six fields, of which two were infested by two species, only four fitted with a probability greater than .05, and six greater than .01. Because no consistent deviations appeared in the distributions having poor fits, the negative binomial may be used at least tentatively to describe the distributions of egg-pods of *M. m. mexicanus* and *C. pellucida* in stubble fields.

3. Large-scale variations in topography and vegetative cover are capable of affecting egg-pod distribution, and these factors may be responsible for some observed significant deviations from the negative binomial. Micro-habitat variations, especially in vegetative cover, may effect local concentrations and thus be responsible for the fundamental nature of the distribution.

4. In a field in which *M. m. mexicanus*, and *C. pellucida* were present in the egg stage in about equal numbers their egg-pods were distributed similarly. There was a highly significant association of eggs of the two species in the same sample units ($r=.44$).

Acknowledgments

This study was based on data obtained in investigations on tillage for the control of grasshoppers, begun under the direction of Dr. R. H. Handford, now of the Entomology Laboratory, Kamloops, B.C., then Co-ordinator of Grasshopper Research in Canada. Later the tillage investigations were under the direction of the late Mr. H. W. Moore. Numerous devoted persons assisted in the labour of sampling. Mr. D. E. Davies, of the Anti-Locust Research Centre, London, England, kindly read and criticized the manuscript.

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Intestinal Myiasis of a Human Caused by Maggots of the Flesh-fly, *Sarcophaga haemorrhoidalis* (Fln.) (Diptera: Sarcophagidae), in Southwestern Ontario

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During August of 1955 a farmer, 35 years old, in Metcalfe Township, Middlesex County, Ontario repeatedly passed living maggots in feces during bowel movements. Four of these maggots were received by the writer on August 30, 1955 and were placed in an inch of damp soil in a screen-covered jar. On September 13 two sarcophagid flies, one male and one female, emerged from the soil and on September 14 two more males emerged. They were examined by Mr. G. E. Shewell, Systematic Entomology, Department of Agriculture, Ottawa, who identified them as *Sarcophaga haemorrhoidalis* (Fln.). The four specimens are deposited in the collection of the Department of Zoology, University of Western Ontario.

The farmer reported to the physician treating the case that he experienced pain before bowel movements and that the living maggots were ejected in large numbers with the feces. He also recounted that the same condition, associated with passing of maggots, had occurred over a period of about one month during parts of July and August in the previous two years.

Several authors have recounted cases of intestinal myiasis caused by sarcophagid maggots. Aldrich (1916) reports two cases involving *S. haemorrhoidalis* and Matheson (1950) refers to five other cases of invasion of human tissues by maggots of the genus *Sarcophaga*. A case reported by Herms and Gilbert (1933) is similar to the one reported by the present writer in that the patient experienced invasions of maggots in two successive years and adult flies of the genus *Sarcophaga* as well as of *Calliphora* and *Lucilia* were reared from the maggots. The authors, pointing out that the mode of life of the patient probably precluded repeated infestations, advanced the possible explanation that the maggots reproduced by paedogenesis in the digestive tract, as suggested by Parker (1922). Keilin (1924) called attention to defects in Parker's methods which could have allowed fresh infections of his culture media from external sources; and he demonstrated in his own experiments that *Calliphora erythrocephala* does not reproduce by paedogenesis.

Entrance of maggots into the digestive tract of a human is generally attributed to ingestion with food or to access of the maggots through the anus (Chandler, 1955). The farmer in Metcalfe Township stated that he passed the maggots during the time that he ate green peas and green beans but no check was made to see if flies or larvae were present about or on these foods. The

likelihood is, however, that the larvae were ingested with some food on which they had been deposited by female flies.

The clinical data pertaining to this case were contributed by G. D. Vine, M.D., Strathroy, Ontario, who was the physician treating this case and the maggots were submitted to the writer, for rearing, by W. M. Wilson, M.D., of the Regional Laboratory, Ontario Department of Health, London, Ontario.

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Biology of the Superb Plant Bug, *Adelphocoris superbus* (Uhl.) (Hemiptera: Miridae), in Southern Alberta¹

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The superb plant bug, *Adelphocoris superbus* (Uhl.), is a serious pest in some alfalfa seed fields in southern Alberta. It feeds on the unopened bud clusters, causing them to whiten and die (bud-blasting). Under cages, it has also caused flower-drop, stunting of plants, and destruction of immature seed (Sorenson, 1954). When numerous it may prevent fields from producing enough bloom for the alfalfa pollinators in the vicinity, and in such numbers is of economic importance to the seed-growers. The number of bugs necessary for an economic population thus varies inversely with the pollinator population on the field.

Sorenson (1954) stated that discontinuing the growing of seed from first-growth alfalfa in Utah reduced superb plant bug numbers to non-economic levels; he found that all eggs and most young nymphs were destroyed with the cutting of the early stand for hay. In southern Alberta, seed is produced from first-growth alfalfa because of a shorter growing season. The species is therefore likely to continue to be a problem in this area. This is a report on its biology for which the field work was carried out in an irrigated area near Scandia, approximately 75 miles northeast of Lethbridge, Alberta, during the seasons of 1951 to 1953.

Materials and Methods

To determine natural oviposition sites of the species, samples of alfalfa stems from one square foot of surface were taken at random during the fall of 1951 from a heavily infested field. Adults were caged over growing alfalfa plants to

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obtain eggs. Stems were examined under low-power magnification; egg sites, egg numbers, and widths of stems selected were recorded.

To discover the degree of development attained before winter by eggs deposited in the field, random samples of stems were gathered on a number of occasions until November 27. Sampling was continued the following spring, beginning on April 22, to find when development was resumed. Eggs found in these samples were removed from the stems, immersed in water, and examined for embryological development under low-power magnification and transmitted light. Eggs were then separated into four categories: those showing no visible embryological development, slight development, and extensive development, and those that had hatched. Counts were compiled on a percentage basis for comparison. To determine the effect of chilling on embryological development, approximately 250 eggs collected in the field during late fall were divided into two equal groups. One group was exposed to $37 \pm 2^\circ\text{F}$. for 140 days and then removed to room temperature, and the control group was kept at room temperature; both groups were kept moist and checked daily for hatching.

The sweep method was used to determine the rates and periods of development of field populations of the pest and its predators. Periodic samples were taken in alfalfa with a standard 14-inch net throughout the summers of 1951 and 1952. A full-arm sweep was taken every two paces as the collector walked briskly into the wind and as nearly as possible toward the sun. Each sample consisted of a minimum of 50 sweeps; more were taken where populations were low. Captured specimens of *A. superbis* were separated according to stages, and percentages of each recorded. Identification of the various instars was based on differences in size and shape of nymphs, and on the extent of wing-pad development. First-instar nymphs had a more strongly pointed head-capsule than the second; wing pads became apparent in the third instar and elongated in the fourth and fifth. Sorenson (1954) has since published excellent drawings of each stage.

Periodically during 1952 samples of adult females of *A. superbis* taken in sweeping were dissected and examined for presence of eggs to obtain some indication of the extent of the egg-laying period.

During 1952 and 1953 various species of plants growing in and around the alfalfa seed-producing districts were examined to discover alternative hosts of the bug. Legumes, particularly sweet clover, *Melilotus* spp., wild licorice, *Glycyrrhiza lepidota* Pursh., and vetches, *Vicia* spp., were examined and swept, as were various species of Cruciferae and Compositae.

Oviposition

Eggs are deposited within the stems with only the caps projecting slightly above the plant epidermis (Fig. 1). The minute, oval caps appear as tiny specks to the unaided eye. The eggs examined averaged 1.3 mm. in length and had an average width at the widest portion of 0.35 mm. They are cylindrical, slightly curved, with a truncated cap and a smooth, shiny chorion (Fig. 2). The contents in undeveloped eggs are granular in appearance and of a pale-orange colour.

Mean widths of alfalfa stems at oviposition sites from field and caged samples grown at Scandia in 1951 and 1952 were:—

Sample	Year	No. of measurements	Mean stem width, mm.	Fiducial limits at 1% level
Caged	1951	180	1.04	0.99-1.10
Field	1951	100	1.07	1.00-1.14
Caged	1952	285	1.01	0.98-1.04

TABLE I

Percentages of eggs of *A. superbus* found in various portions of alfalfa stems, Scandia, Alberta

Origin of alfalfa	Number of eggs examined	Upper 4 inches of stems	Branches and fragments	5 to 8 inches from tips of stems	9 to 12 inches from tips	Basal 4 inches of stems
Caged, 1951	295	43.1	23.7	22.0	7.5	3.7*
Field, 1951	1,260	59.5	29.1	10.4	1.0	0.0
Caged, 1952	266	62.4	14.3	18.1	5.2	0.0

*All eggs found in one spindly, second-growth stem.

These data showed that stem widths at oviposition sites were not significantly different in material caged in the two seasons or in caged and uncaged material in 1951. This indicated that the bug confined egg laying to a narrow range of stem widths. Eggs were always found in square stems and branches of secondary growth or in the square, upper, younger portions of older stems. The percentages of eggs found in various portions of alfalfa plants are summarized in Table I.

As fragments that broke off when stems were being collected consisted of pieces of branches and terminal growth, eggs found in them were included under "branches and fragments". Females of *A. superbus* oviposit most frequently in thin-walled stems, probably because these are penetrated more easily, or their shape and width facilitate oviposition, or both. Eggs were not found in the more heavily lignified and rounded, larger portions of the stems. Hughes (1943), working with the closely related species *A. lineolatus* (Goeze) in Minnesota, found that under cages in early summer the eggs were deposited in the stems a foot or more above the ground but that overwintering eggs were laid closer to the stem bases. He reported that the insects seemed to choose the older and less succulent growth in late summer, possibly because it provided more protection for the overwintering eggs. He also stated that the stem occasionally splits for several inches beyond the point of oviposition; this seems to indicate that the plant tissue was more mature at time of oviposition. Sorenson (1954) also reported that where many eggs of the superb plant bug had been laid in a row stems were usually split open. Splitting was not observed at oviposition sites in alfalfa in southern Alberta.

In southern Alberta, the majority of eggs are laid in those portions of the plants that are spread back on the fields during harvesting operations. During winter, plant material and snow cover normally protect them from low temperatures, and nymphs that hatch the succeeding spring are in a favored position to re-infest new growth rapidly.

Fig. 1. Egg caps of *A. superbus* protruding from surface of alfalfa stem (Photomicrograph, approximately X22).

Fig. 2. Longitudinal section through an alfalfa stem showing eggs of *A. superbus* (Photomicrograph, approximately X25).

Fig. 3. A group of eggs of *Sinea diadema* adhering to a stem of alfalfa (Photomicrograph, approximately X15).

Fig. 4. A group of eggs of *Phymata fasciata* adhering to a stem of alfalfa (Photomicrograph, approximately X11).

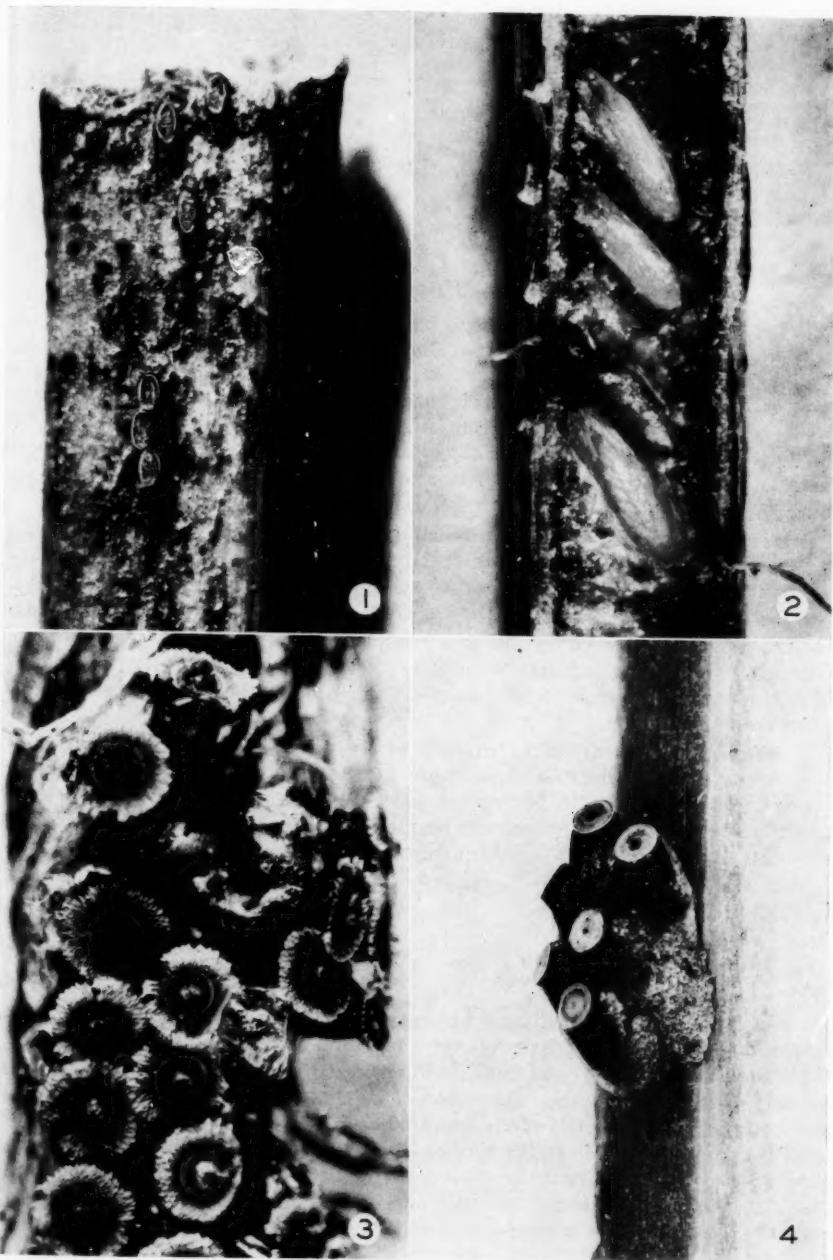


TABLE II
Percentages of eggs of *A. superbus* at various stages of development in the field from October to May; Scandia, Alta.

Date collected	No. of eggs examined	Complete development	Extensive development	Slight development	No development
Oct. 11, 1951	200	0.0	0.0	0.0	100.0
Nov. 7, 1951	300	0.0	0.0	0.0	100.0
Nov. 27, 1951	100	0.0	0.0	0.0	100.0
Apr. 22, 1952	50	0.0	0.0	0.0	100.0
May 13, 1952	50	6.0	6.0	4.0	84.0
May 29, 1952	47	27.7	12.7	38.3	21.3

Seasonal Development

Table II shows that there was no observable embryological development in eggs in the field until spring. Hatching began on May 13 in 1952. As no nymphs were taken in sweeps on that day, however, it is likely that the percentage recorded in Table II was unduly high because of the small number of eggs examined. Cool, wet weather from May 13 to May 21 probably retarded embryological development as only eight specimens were taken in 50 sweeps on May 29. In 1953, only one first-instar nymph was taken in 100 sweeps on June 1.

In the laboratory, no eggs hatched in the control group. In the group exposed to chilling, 67 per cent of 118 eggs hatched during 45 days beginning 16 days after the eggs were removed to room temperature.

Because the eggs showed no development at the onset of winter, and because no development occurred in the group not exposed to chilling, an obligatory diapause is apparently initiated soon after they are laid. This ensures survival of the species in Alberta, where summers are usually too short to allow two generations to develop.

Seasonal development after hatching of *A. superbus* in the field during 1952 is shown in Fig. 5. Because there might be some doubt concerning the stages found from August 11 to September 19, 1952, the percentages in each stage taken in sweeps during a comparable period in 1951 are presented below. They show no second-generation build-up during this time.

	First	Second	Third	Fourth	Fifth	Adult
July 26	0.5	0.5	21.9	49.4	12.5	15.6
Aug. 6	—	—	3.1	4.7	21.2	71.0
Aug. 13	—	—	—	1.2	7.3	91.5
Sept. 7	—	—	—	—	1.2	98.8

Fig. 5 indicates that hatching becomes general in early June and continues for more than a month. Rate of hatching would no doubt be influenced by fluctuations in weather conditions; cold, wet weather during late May, June, or early July would lengthen the period of hatching. These results also indicate a diapause in that, although adults appeared as early as July 2 and gravid females were found from July 14 to September 19 in 1952, there was only one complete generation, with no evidence of even a partial second. Sorenson (1954) stated that two generations develop annually in Utah. He found that, under caged conditions, *A. superbus* required nine and 21.5 days for the preoviposition and incubation periods respectively. Hence, if there were a second generation in Alberta it would be expected to begin about 30 days after the first adults were taken. In 1951 this would have occurred about August 12, but on August 13

fourth-instar nymphs were the youngest captured. In 1952 early-instar nymphs would have been re-appearing about August 2. Counts on August 11 showed that the youngest nymphs were in the fourth instar and the percentage of these was very small. Sorenson (1954) also reported that earliest hatching of over-

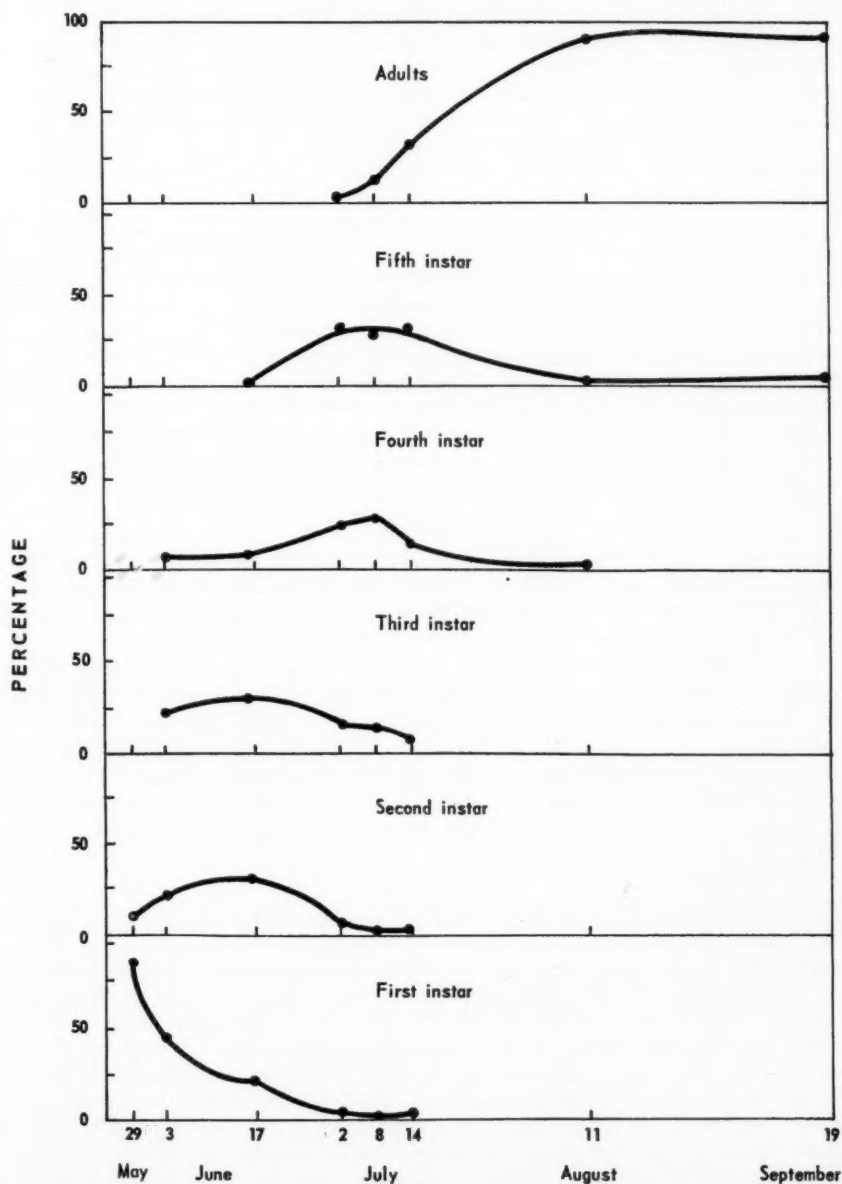


Fig. 5. Percentages of various stages of *A. superbus* captured on sampling dates, Scandia, Alta., 1952.

wintered eggs in the field was observed on May 5 and oviposition occurred from June 15 to mid September. A comparison of results suggests that, because not one second-generation nymph was taken in Alberta, the bugs are morphologically similar but differ physiologically.

Host Plants

Sorenson (1954) reported that alfalfa was the chief host of this insect and that he had not collected the bug from any other native or cultivated plants in Utah. Gillette and Baker (1895) took it on "*Senecio douglassi*" in Colorado. It has been listed as a pest of cotton in New Mexico by Eyer and Medler (1942) and in Arizona by Stevenson and Kauffman (1948). It is noteworthy that the two hosts on which this bug is most abundant are introduced species belonging to different families.

In southern Alberta, after prolonged search among native and cultivated plants, a small population was found on a patch of Canada thistle, *Cirsium arvense* (L.) Scop., on virgin prairie approximately a mile from any alfalfa. A number of *A. superb* eggs were found in stems taken from this patch of thistles on October 30. As in the alfalfa, the eggs were deposited in the younger, square portions of the stems. During the following summer the thistle patch was kept under observation and all stages of the species were taken. On July 24, 1952, two adults were observed on another species of thistle at least 10 miles from any alfalfa. These observations show that this pest can reproduce on *Cirsium* sp(p). These plants could therefore serve as natural reservoirs for infesting alfalfa grown in new agricultural areas, or for re-infesting treated fields.

Predators

When searching for eggs of *A. superb*, those of two species of predacious insects, *Phymata fasciata* (Grey) (Phymatidae) and *Sinea diadema* (Fabr.) (Reduviidae), were found. Overwintering eggs of both species were cemented in groups on the surfaces of alfalfa stems (Figs. 3 and 4).

The following table shows total numbers of both species of predators in relation to total numbers of *A. superb* (nymphs/adults) swept from the field in 1952:—

Species	June 17	July 2	July 14	Aug. 11	Sept. 4
<i>A. superb</i>	714/0	313/14	164/74	0/12	0/4
<i>S. diadema</i>	3/0	5/0	33/0	0/11	0/5
<i>P. fasciata</i>	4/0	1/0	18/2	0/18	0/9
Ratio of pest to predators	102:1	54.5:1	4.5:1	0.4:1	0.3:1

Each day's count were obtained from 250 sweeps. The numbers of nymphs and adults for the three species indicate that *A. superb* reaches the adult state a little before or at about the same time as the predators. Because most of *A. superb* had reached the adult state and had begun to disperse from the nymphal feeding sites before August 11, little significance can be placed on ratios from then on; earlier counts, however, suggested that the predators were at least partially responsible for the decrease in the pest population. Taylor (1949), when studying the life-history of *Nabis alternatus* Parshley (*Nabidae*), found that each predator while developing from a first-instar nymph to an adult devoured an average of 29 lygus bug adults; almost as many superb plant bugs would probably have been required. Because *N. alternatus* is much smaller than either *S. diadema* or *P. fasciata* it seems reasonable to assume that their food requirements would be greater. In the field on at least two occasions

S. diadema was observed to feed on nymphs of *A. superb* and in the laboratory both species fed freely on nymphs and adults of this pest. Of 20 third-instar nymphs of *S. diadema* brought from the field and reared in individual containers seven reached the adult stage. Two of the seven consumed 14 and 15 adults and late-instar nymphs of *A. superb* respectively; four consumed an average of 17.3 lygus nymphs and adults, and one fed on an aggregate of 20 lygus and superb plant bugs. These data give some indication of the food requirements of *S. diadema* and of its value as a predator of plant bugs in alfalfa. Although experiments were not carried out with nymphs of *P. fasciata* it is suspected that their requirements would be as great.

Summary

Females of the superb plant bug, *Adelphocoris superb*, a pest in scattered alfalfa seed fields in the irrigated district surrounding Scandia, Alberta, lay eggs in square, non-lignified portions of alfalfa stems with average widths of about one millimeter. Terminal portions of older plants and spindly second growth are preferred oviposition sites. The eggs apparently enter diapause soon after they are laid, and show no signs of embryological development until the following spring. Hatching usually becomes general early in June and continues for more than a month. Although some reach the adult stage as early as July 2 and gravid females are found from mid July until after mid September, there is no second generation in southern Alberta. Because *A. superb* has only one generation per year and lays its eggs in terminal growth, it becomes a pest only in those fields in which cultural operations do not destroy young nymphs or overwintered eggs. This is probably why it is not common in hay fields, or in alfalfa seed fields that have been burned in the spring. *Sinea diadema* and *Phymata fasciata* are important predators of *A. superb* in alfalfa seed fields in this region. Alfalfa is the principal host of this pest but it can also reproduce on Canada thistle. Although *A. superb* in southern Alberta is morphologically similar to that in Utah, it appears to be of a different physiological strain.

Acknowledgments

The writers wish to express their appreciation to Drs. B. Hocking, University of Alberta, Edmonton, and R. W. Salt and N. D. Holmes, Science Service Laboratory, Lethbridge, Alberta, for guidance in the studies and in writing the manuscript; and Mr. D. Cox, Scandia, on whose farm much of the experimentation was carried out and who was extremely co-operative at all times.

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***Geshna primordialis* Dyar, with Descriptions of Two New Genera and Two New Subspecies (Lepidoptera: Pyralidae)¹**

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Dyar in 1907 described the genus *Geshna* with the type *Hydrocampa cammalis* Quaintance. In the same publication he described the new species *Geshna primordialis*. Forbes (1923) noted that *primordialis* was only doubtfully referable to *Geshna*; but he did not remove it from the genus. In this paper I describe a new genus for *primordialis*, two new subspecies of that species, and a new genus for the related *Isopteryx stenialis* Guenée.

***Anageshna*, new genus**

Type: *Anageshna primordialis*, new combination, = *Geshna primordialis* Dyar, 1907.

Frons rounded, not at all prominent; eye large; ocellus prominent; labial palpus short, porrect, with first and second joints long-scaled below, third joint exposed, acuminate; maxillary palpus slender, pointed, reaching nearly as far forward as labial palpus; antenna with alternate scale-rows raised; body and legs moderately slender; fore coxa obliquely compressed; hind tibia of male with outer spurs about half length of inner; tympanic flap heart-shaped, of moderate size. Forewing with R_1 arising a little before end of cell; R_{2+4} arising from angle of cell, R_2 stalked with R about half-way from cell to margin; R_5 arising a little below angle of cell, not approximated to R_{2+4} ; M_1 arising a little below R_5 ; discocellular erect, with an inward angulation in posterior half; M_2 , M_3 and Cu_1 arising close together at end of cell, their basal portions weakly curved and approximated; anal loop open. Hind wing subquadrate, outer margin with strongest curvature opposite M_3 ; Sc and R_s anastomosed nearly to outer margin; M_1 and R_s stalked for a considerable distance; discocellular excurved posteriorly, lower angle of cell acute; M_2 and M_3 from lower angle of cell, weakly curved and approximated in their basal portions; Cu_1 from just before angle of cell, not approximated to M_3 ; Cu_2 arising a little more than half-way out on cell.

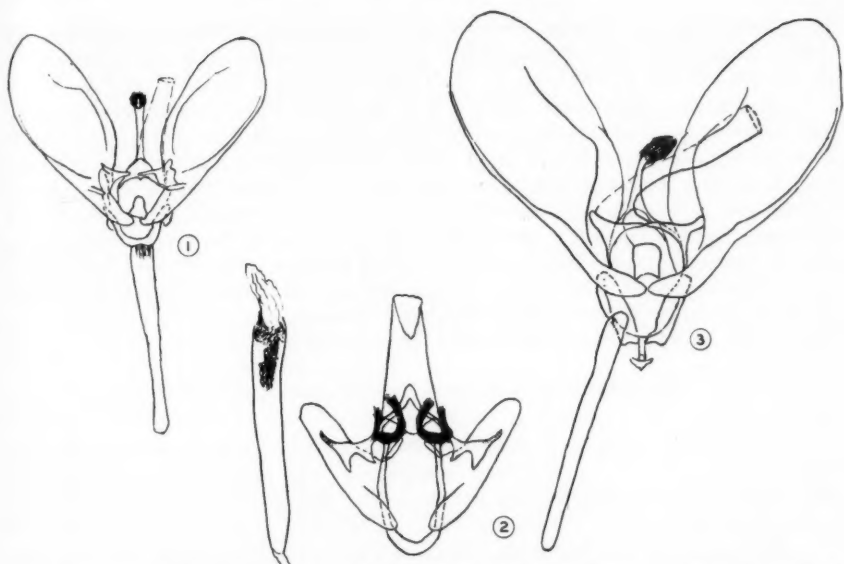
Male genitalia (Fig. 1): uncus slender, tip expanded, decurved and armed with anteriorly directed dorsal spines; valve broad, ovate, costa and sacculus weakly inflated; transtilla slender, medially constricted; juxta small, obovate; aedoeagus cylindrical, somewhat expanded distally; vesica with some irregular scobinations.

Female genitalia: ductus bursae long, slender and coiled; bursa globular; both structures membranous and unarmed.

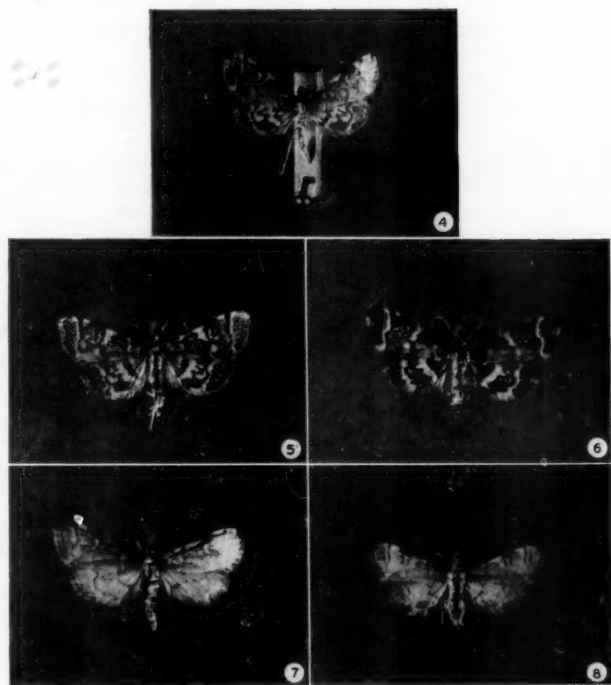
The new genus differs in a large number of characters from *Geshna*, which has quite different genitalia (Fig. 2). It is much more closely related to *Isopteryx stenialis* Guenée. This relationship was recognized by Forbes (1923), but he erred in supposing that the two species are related to *Nymphula*; in fact they, like the related *Diathrausta*, are Pyraustinae, lacking the chaetosema and gnathos. *Stenialis* has been placed by recent authors in *Blepharomastix* but, as I pointed out in 1950, it does not belong there. In spite of the strong structural similarity to *Anageshna*, *stenialis* differs in having R_2 of the fore wing from the cell, and not stalked with R 3+4, and in having the discocellular of the fore

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Figs. 1-3. Male genitalia. 1, *Anagesbna primordialis* (Dyar). 2, *Gesbna camalis* (Quaintance), juxta omitted. 3, *Apogesbna stenialis* (Guenée).



Figs. 4-8. *Anagesbna primordialis* (Dyar), x2. 4, *A. p. primordialis*. 5, 6, *A. p. vividior*, ♂, ♀. 7, 8, *A. p. pallidior*, ♂, ♀.

wing excurved. I consider that *stenialis* represents a distinct genus, which I name *Apogeshna*, new genus, type *Apogeshna stenialis*, new combination = *Isopteryx stenialis* Guenée, 1854. The male genitalia are shown in Fig. 3.

Anageshna primordialis (Dyar) was described from a considerable series of syntypes, from a wide range of localities from Quebec to Texas. As I have none of the type series before me, I refrain from selecting a lectotype. In order to clarify the names of the subspecies, however, I restrict the type locality of the species to Pennsylvania and New Jersey, from which states eight of the syntypes came. To judge from a short series in the C. N. C., the population of the restricted type locality consists on the average of small, dark, obscurely marked specimens (Fig. 4). The two specimens in the C. N. C. from the Austral Zone of southern Ontario (Grand Bend and Normandale) agree with those from New Jersey, and I refer them to the typical subspecies.

***Anageshna primordialis vividior*, new subspecies**

Figs. 5, 6

Larger than the typical subspecies, averaging nearly 15 mm. in expanse, as against 12.75 mm. Ground colour averaging a little paler, transverse dark and pale bands more conspicuous than in the typical subspecies, and the pale markings more extensive.

Holotype, ♂, Mer Bleue, near Ottawa, Ont., June 27, 1935, T. N. Freeman; Allotype, ♀, Ottawa, Ont., June 18, 1946, T. N. Freeman.

Paratypes.—63 specimens from the following localities: *Ontario*: Ottawa; Mer Bleue, Hawthorne; Bobcaygeon; Orillia; *Quebec*: Meach Lake; Clement; Kazubazua; Georgeville; Norway Bay; Aylmer; Knowlton; *New Brunswick*: Waweig; Tabusintac; Chamcook; Eel River. Type No. 6300, C. N. C.

***Anageshna primordialis pallidior*, new subspecies**

Figs. 7, 8

Size about the same as in *A. p. vividior*. Ground colour much paler than in other subspecies, fore wing light silvery grey and hind wing mostly whitish buff. Pale transverse markings much expanded, hardly contrasting; dark transverse bands very weak and obscure.

Holotype, ♂, and allotype, ♀, South Milford, N.S., June 23, 1934, J. McDunnough.

Paratypes.—46 specimens from the following localities: *Nova Scotia*: South Milford; Annapolis; Mt. Uniacke; Petite Rivière; Baddeck; Cape Canso; Ottawa House, Parrsboro; *Prince Edward Island*: Alberton; Brackley Beach, Canadian National Park. Type No. 6301, C. N. C.

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The Influence of Spray Programs on the Fauna of Apple Orchards in Nova Scotia. IX. Studies on Means of Altering Predator Populations¹

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It has been established that a complex of predacious arthropods on apple trees in Nova Scotia can control phytophagous mite populations (Lord, 1949). Some of the predators, when sufficiently numerous, may also be important in the control of other pests such as the eye-spotted bud-moth, *Spilonota ocellana* (D. & S.), and the codling moth, *Carpocapsa pomonella* (L.). When predation has reduced the mite population to small numbers, the insect predators almost disappear from the orchard. In most orchards in this province, the use of spray materials innocuous to predators has greatly reduced the phytophagous mite populations. The low mite population is an important gain but it is not known whether the attendant small numbers of predators is advantageous in the natural control of pests in general. This will be answered in time by the experience of the growers and, meanwhile, further research is needed on the interrelations of the phytophagous and predacious species and on how they are affected by orchard practices and other factors. This involves studies on the food preferences and behaviour of many species. In addition, means must be found to modify cultural practices to make conditions as favourable as possible for certain species of predators.

This is a preliminary report on an attempt to alter the populations of certain species and to study the interactions of phytophagous mites with various groupings of predators. DDT was used to disrupt the interactions to differing degrees at different times of the growing season and the biotic reactions that followed were recorded as far as possible.

The studies to date have been largely confined to observations on the predator populations during the periods when they may be found on apple trees. One of the difficulties in the study is that many of the arthropods found on apple trees are not specific to them: the more motile species of predators, in particular, move freely between the fruit trees and other plants in their environment. This complicates attempts to exercise some control over the number of predators in the orchard but furnishes a means of increasing the predator populations rapidly if the density of the prey warrants it.

Methods

It is extremely difficult to observe the behaviour and the interactions of predators and prey in their natural habitat. Some indirect method was needed to create varying quantitative relationships between, in this instance, phytophagous mites and their predators. For this purpose, it seemed feasible to disrupt the predator-prey relationships by an insecticidal method, highly modified from that of DeBach (1946). Various dilutions of DDT (Fig. 1) were used at several periods of the year to achieve this end. DDT was chosen since it is largely innocuous to phytophagous mites but was assumed to be toxic to most of the predators in varying degrees, depending on the time of application and on the concentration.

The North Sawler orchard, in which the experimental work was conducted, consists of 40 rows of ten trees each, the variety Gano predominating. This

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orchard is relatively isolated from others, the nearest being 200 yards away, and is surrounded by uncultivated land. Since 1945 it has been treated with regular applications of fungicides relatively innocuous to arthropods and has received the minimum of insecticides. The fauna of the orchard was, therefore, not disturbed to so great a degree as in most commercial orchards. The fungicides had no great significance in the studies beyond the need to control the apple scab fungus, *Venturia inaequalis* (Cke.) Wint. In 1953 the fungicides were copper oxychloride sulphate and glyodin and in 1954 ferbam and captan. The ferbam was used in 1954 to destroy phytoseiid mites, which, though important predators, could complicate the studies on the habits of other predacious insects. The plots were single rows, every third row being left untreated so as to serve as a reservoir for predators. DDT was applied in 1953 only, but the plots were sampled during the summer of 1954 as well.

No rapid and accurate means of sampling the populations of the more active predators seems to be available. The method used, jarring predators onto a cloth-covered tray, however, gives a rough estimate with a reasonable expenditure of time. One side of each of two trees was sampled per plot on each sampling date and six weeks usually elapsed before the same sides of the same trees were sampled again. The number of each species of known predacious habits found on the tray was recorded, including species that do not feed on mites, e.g., the mirid *Phytocoris conspurcatus* Knight, pentatomids, coccinellids, representatives of several other families of insects, spiders, and a few Acari. Some of the species in these groups occasionally seize a mite but are of minor importance in mite control: the mite *Anystis agilis* Banks, for instance, will feed on mites but is frequently found on neglected trees in large numbers where the mite population is very low. In Figs. 1-3, only species known to be of at least moderate importance in the natural control of mites were included.

Estimates of the mite populations were based on samples of 100 leaves per plot taken periodically throughout the summer but not necessarily on the same day on which the predators were sampled. Approximately eight leaves were taken from the outer parts of each of six trees, eight from the inner or more shaded portions, the total brought to 100 leaves and examined with the aid of the counting device described by Henderson and McBurnie (1943). The population density of the eriophyid *Vasates schlechtendali* (Nal.)¹ was estimated by counting the mites on one sector of the plates only.

Results and Discussion

Phytophagous Mites

The figures for the populations of the European red mite, *Metatetranychus ulmi* (Koch), and of the clover mite, *Bryobia praetiosa* Koch, were combined in the curves for mites per leaf. Figs. 1-3 show the changes in the mite and predator populations for June through August, 1953, the year the DDT was applied, and for a similar period in the following year. The first series of DDT treatments, applied in May, 1953, created conditions early in the season conducive to increases in the mite populations. These treatments were made when the predators, for the most part, were still inactive so that little immediate harm was done to them. The detrimental effects were caused by the residues of DDT and varied with the amount of DDT used, the time elapsing before their appearance, and their relative susceptibilities. The increases in mites on these four plots started early in 1953, reached their peaks by mid-summer and, with the re-establishment of predator populations, began to decline in late summer. During the following year the populations of mites were at or

¹Identified by Dr. A. M. Massee, East Malling Research Station, East Malling, England.

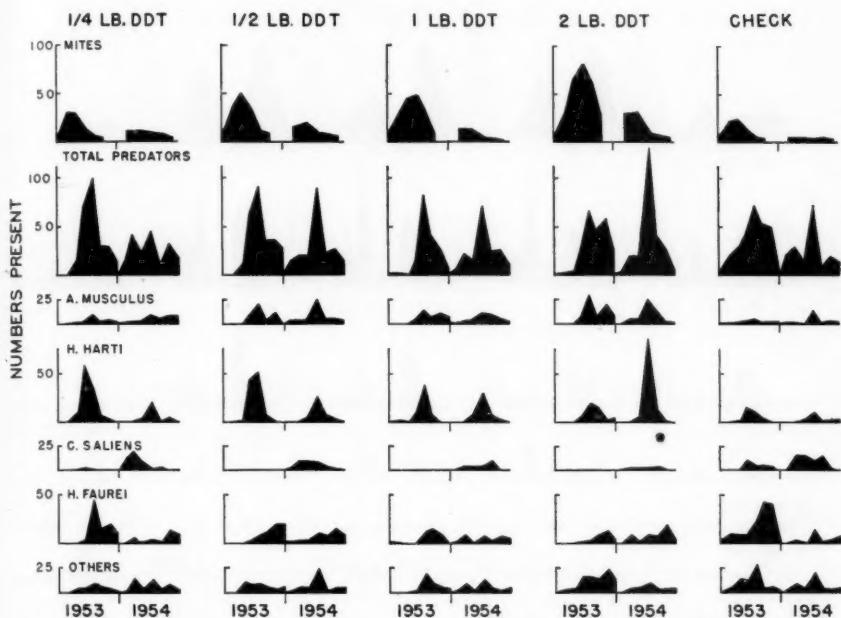


Fig. 1. Numbers of phytophagous mites per leaf and of predators per tray taken from halves of two trees for June through August, 1953 and 1954, on apple plots sprayed with various amounts of DDT on May 1, 12, and 20, 1953.

near an average low level with a sufficient number of predators to maintain balance.

The second series of DDT applications, from mid June to early July, was made at a time when practically all the predators might be affected. The residues prevented infiltration of predators until late in the summer. The freedom from predation from mid June until the late summer of 1953 allowed heavy increases in the mite populations (Fig. 2). Owing to the effectiveness of the DDT in eliminating predators at this critical period, half a pound favoured the development of as high a peak of population of mites as greater amounts. There was some infiltration of predators in the fall but not sufficient to prevent fairly heavy deposition of winter eggs by the mites. The relatively dense mite populations in 1954 provided conditions favourable for predation and, as shown in Fig. 2, there were high populations of predators and a rapid reduction of the mite populations.

The DDT applications in late July and early August of 1953 caused no great changes in the populations of mites on the leaves the same year (Fig. 3). There were, however, heavy depositions of winter eggs on the bark so that rapid and early increases took place in the mite populations in 1954. The increases in the predator populations were delayed but the predators checked the mite populations in the late summer of 1954.

The red mite and the clover mite populations are indicated separately for comparison in Fig. 4. These curves show that the increases shown in Figs. 1-3 were largely due to the more rapid build-up of the red mite.

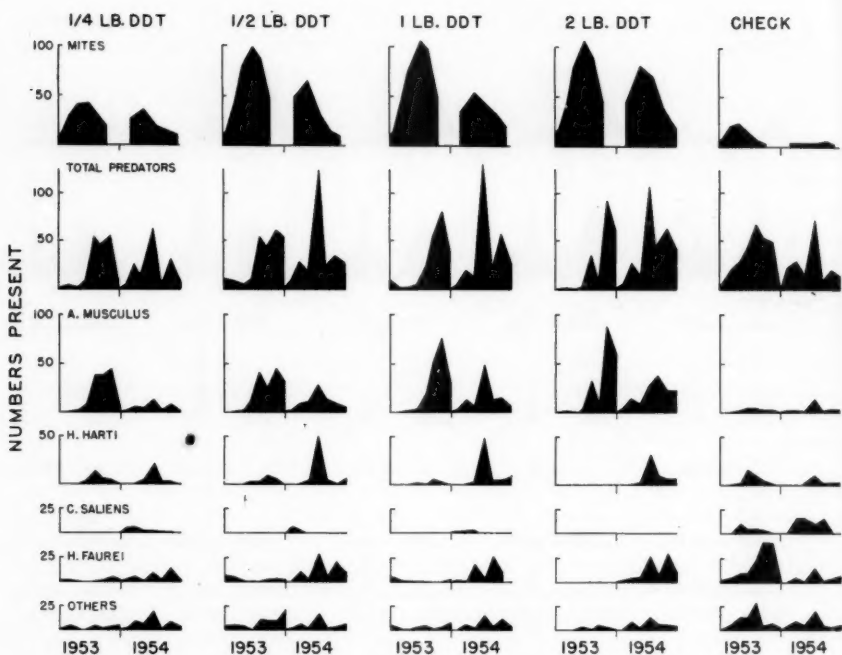


Fig. 2. Numbers of phytophagous mites per leaf and of predators per tray taken from halves of two trees for June through August, 1953 and 1954, on apple plots sprayed with various amounts of DDT on June 12, 22, and July 6, 1953.

The eriophyid mite *Vasates schlechtendali*, commonly found on apple foliage, is a free-living species of no known economic importance. These eriophyid mites were not eliminated by the DDT treatments but appeared to be rather vulnerable to DDT applied in July and August (Fig. 5). The populations of *V. schlechtendali* on all plots in the following year (1954) were remarkably uniform. Since none of the predacious species was evenly distributed over all plots, a tentative conclusion is that none of the predators found exhibit any strong tendency to be a density-dependent mortality factor for the eriophyids.

An unidentified species of Cecidomyiidae appeared to be one of the more important control agents for eriophyids but there are no records of the effects of DDT on this predator. Miss H. J. Herbert of the Kentville laboratory found evidence that the predacious mite *Phytoseius macropilis* (Banks) also will prey upon *V. schlechtendali*. The phytoseiids, however, were not important agents in the control of mites in this experimental orchard.

Anthocoris musculus (Say)

This anthocorid has commonly been found in Nova Scotia in association with high mite populations. It probably has a wide range in its choice of prey, but when present in sufficient numbers it can be an important control agent for mites. Since *A. musculus* has more than one generation a year and is highly motile, it can move readily from one apple tree to another or to and from other plants. Experience has shown that sudden increases in the numbers of

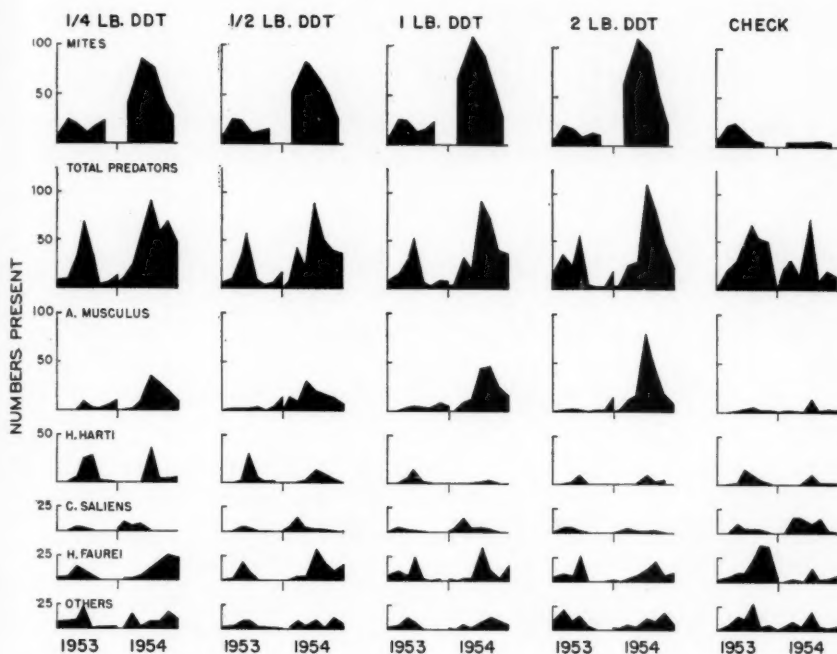


Fig. 3. Numbers of phytophagous mites per leaf and of predators per tray taken from halves of two trees for June through August, 1953 and 1954, on apple plots sprayed with various amounts of DDT on July 16, 29, and August 11, 1953.

A. musculus on apple trees in response to high mite populations are not uncommon. The increases have, to a large extent, followed the use of DDT since *A. musculus* tolerates more DDT than most predators.

The numbers and distribution of this anthocorid in the experimental plots support the generalizations just made. Its toleration of DDT allowed it to increase or infiltrate in numbers proportional to those of the mites present regardless of the amount of DDT used. The four plots treated in May, 1953 (Fig. 1), did not show so great increases in mites as the plots treated in mid season (Fig. 2); the changes in the anthocorid populations were in proportion to the numbers of mites. When the DDT was applied in late July and early August of 1953, there was no notable increase in mites or *A. musculus* that year (Fig. 3); the early, large increases in the mite populations on these four plots in 1954, however, promoted both the natural increase and the infiltration of large numbers of anthocorids.

A. musculus apparently can be a density-dependent mortality factor for mites on apple trees. Although it can increase in numbers through reproduction in the presence of sufficient prey on apple trees, it can become numerous in an orchard just as rapidly through infiltration.

Hyaliodos harti Knight

This mirid is potentially a predator of considerable economic value in Nova Scotia. It not only feeds voraciously on mites but will also destroy the eggs of the codling moth and the eye-spotted bud moth. A means of manipu-

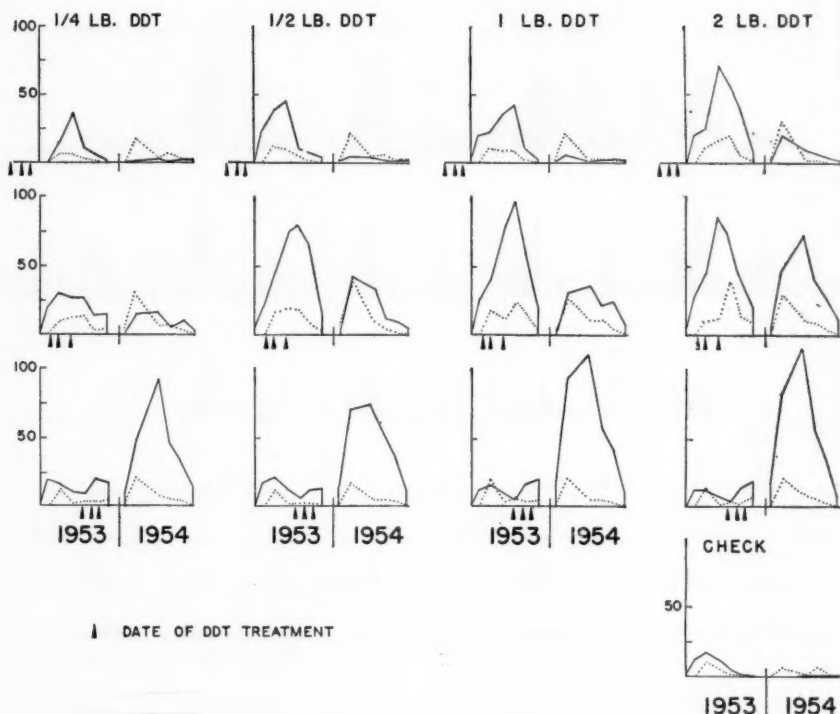


Fig. 4. Numbers per leaf of the European red mite (solid line) and of the clover mite (broken line) in 1953 and 1954 on plots sprayed with various amounts of DDT in 1953 on various dates.

lating conditions to maintain higher numbers in commercial orchards would be of considerable economic value. *H. barti* winters in the egg stage when it remains on the apple trees but nothing is known about it on other host plants.

The nymphs are first seen about the middle of June and mature after the third week in July. Adults are found in the orchard throughout August and a few survive into September. Since there is only one generation a year, *H. barti* can spread into an orchard only in the late summer. Thus the number of nymphs in the spring depends on the conditions in August of the preceding year favouring the establishment of the adult mirids on the apple trees. The adults are very active and usually escape from the trays before they can be counted. In addition, they often gather on the water sprouts and are not then taken on the sampling trays. Thus there may be a much larger population of the adult mirids on the trees than the sampling may indicate.

Three applications of DDT at a quarter of a pound per 100 gallons in May allowed a greater survival of nymphs than on the check trees (Fig. 1). This suggests that the May applications of DDT created more favourable conditions for *H. barti* by reducing the competition for available prey. In 1953 the survival of *H. barti* on these four plots was in inverse order to the amount of DDT, i.e., greatest where a quarter of a pound of DDT was used and least where two pounds were used. During the following year (1954) the

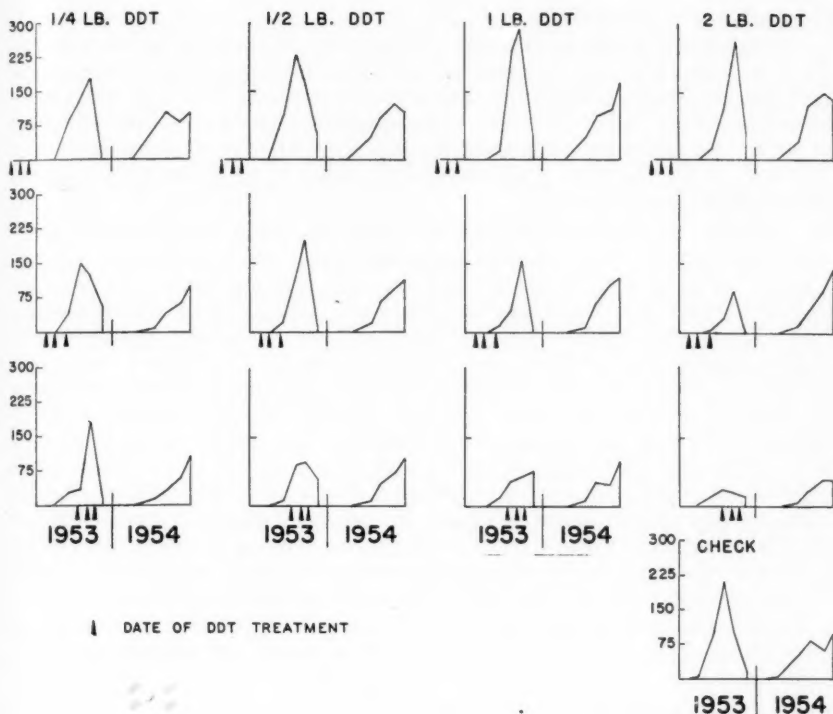


Fig. 5. Numbers of eriophyids per leaf in 1953 and 1954 on plots sprayed with various amounts of DDT in 1953 on various dates.

relationships were reversed, i.e., the number of *H. barti* was proportional to the amount of DDT that had been used. The relative numbers of these mirids per plot in 1954 were determined by the conditions obtaining in August of the preceding year. At that time the DDT had weathered and mirid eggs had apparently been laid in proportion to the number of mite prey.

Applications of DDT in late June and early July, when *H. barti* nymphs were present, were much more drastic in their immediate effects (Fig. 2). These applications were completed and presumably much of the DDT had weathered before the period in which the last of the ovipositing female mirids normally die. The mite populations had increased sufficiently on these plots by August, 1953, to attract large numbers of adults of *H. barti*, which laid eggs for the 1954 generation. The numbers taken in 1954 are not only a measure of this effect but also illustrate that, on these plots, this mirid was fairly important in the control of mites in 1954 (Fig. 2).

The *H. barti* and the mite populations on the plots treated in late July and early August were at much the same low levels as on the check trees at the time the DDT was applied in 1953. In addition, the DDT was an effective barrier to an influx of adult mirids, the biological effects of which were seen in 1954 in the small numbers of nymphs found. The numbers of nymphs, in 1954, on these four plots were in inverse proportion to the amount of DDT used in 1953.

Criocoris saliens (Reuter)

This mirid is found in relatively few commercial orchards in Nova Scotia. As it is fairly common in neglected orchards, some practice in commercial orchards, at present unknown, is apparently detrimental to it. In the experimental orchard *C. saliens* has been a prominent part of the fauna for a number of years. Its active period is from the last week of May until the middle of July and, as for the other predacious mirids, there is no evidence of a second generation in Nova Scotia.

The May applications of DDT were completed before the appearance of *C. saliens* but presumably the residue lasted into June, when it normally appears. The second series of DDT sprays, applied in late June and early July, was concurrent with the period of activity of this mirid. The DDT in these two series, even when applied in weaker dosages, between the middle of May and the middle of June, almost eliminated this species (Figs. 1 and 2). Evidently a few adults moved into these eight experimental plots late in July, 1953, and the conditions for their re-establishment were apparently governed by the amount of DDT residue. The influence of the prey available in July, 1953, on the oviposition of *C. saliens* was overshadowed by the toxic effects of the DDT residue. For instance, the greatest numbers of *C. saliens* in 1954 were found in the plot treated with a quarter of a pound of DDT per 100 gallons in May, 1953, and in which the smallest number of mites was present; no specimens of *C. saliens* were taken in 1954 on the plot sprayed with two pounds per 100 gallons of DDT in June, 1953, even though this plot had the largest mite population in 1953.

DDT treatments in late July and early August (Fig. 3) were too late in the season to affect *C. saliens* as, by this period, it was in the overwintering egg stage.

Haplothrips faurei Hood

This thrips is one of the more important species of predators in Nova Scotia. MacPhee (1953) found evidence that it is a density-dependent mortality factor in the control of mites. Although it does not exhibit a density-dependent relationship with lepidopterous insects, it can be important in the control of the codling moth and the eye-spotted bud moth. It has been found throughout the apple-growing area of Nova Scotia, often in numbers of economic significance. There are several generations a year and the adults are long-lived, so that it is possible for them to move into an orchard at any time during the growing season if conditions are favourable. The food preferences of this thrips are not known but it will feed readily on the eggs of the red mite and the clover mite.

As *H. faurei* is very susceptible to DDT (Figs. 1-3) the use of this material at any time in the growing season may and, in this experiment did, have an adverse effect on them. The data also show that the adverse effects increased with greater quantities of DDT.

Other Predators

The curves for "other predators" in Figs. 1-3 are for only those other species known to be potentially important in the control of phytophagous mites. They did not appear in large enough numbers on the plots for evaluation of the effects of the treatments on individual species. Among them were small numbers of the thrips *Leptothrips mali* (Fitch) and *Scolothrips sexmaculatus* (Perg.); the mirids *Deraeocoris fasciolus* Knight and *Plagiognathus obscurus* Uhler; the coccinellid *Stethorus punctum* (Lec.); and several chrysopids.

Also taken in the sampling were numerous other species of predators, not included in the graphs, of no importance in the control of mites, and in no way affected by the difference in the mite populations. These also were present in numbers too small for the determination of differences due to treatment.

Acknowledgment

The writer wishes to thank Miss H. J. Herbert of the Science Service Laboratory, Kentville, for permission to use data from her unpublished reports.

Summary

DDT was used in varying concentrations and at several periods of the growing season to disrupt the relationships between mites and their predators in a series of apple plots. Reduction in numbers or elimination of predators was followed by an increase in numbers of mites. The concentration of DDT used and the time when it was applied determined the time and magnitude of the peaks of population attained by the mites; the re-establishment of populations of predators; and the time elapsing until an equilibrium of low populations of predators and mites was again attained. Pre-blossom treatments, particularly at the lower dosages, caused less disturbance than later treatments and there was very little continuation of the effects into the second year. DDT had its greatest effects when applied immediately after the bloom period, and caused great destruction of predators and rapid increases to high peaks in number of mites; re-establishment of predators began late in the summer and their attacks on the mite populations continued well into the second year. Late-summer applications apparently protected the mite populations from predation in the fall of the year and large numbers of winter eggs resulted. In consequence, mite populations in these plots reached high peaks during the second year and began to decline in late summer as the predators re-established their populations.

Anthocoris musculus, which preys chiefly on mites and which is rather tolerant of DDT, was the most prominent predator in this series of plots. No other predator among those found showed any appreciable tolerance of DDT, although some escaped its effect by appearing too early or too late. In a few instances, their numbers actually increased owing to the greater supply of prey following the destruction of other predators.

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An Effect of *Bacillus sotto* on the Larvae of *Bombyx mori*¹

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The paralysis of silkworm larvae (*Bombyx mori* L.) caused by *Bacillus sotto* Ishiwata and the extraction of a toxic protein from cultures of this microorganism have been reported elsewhere (1, 2, 3). In preliminary studies of the mode of action, changes have been noted in the pH of the blood of affected larvae.

Fourth- and fifth-instar larvae were fed foliage coated with *B. sotto* toxin and at intervals the blood pH was determined as described by Heimpel (4). Control larvae, reared from the same egg mass, were fed untreated foliage.

The first symptom of 'sotto' poisoning is cessation of feeding (1), and for the initial 20 to 25 minutes the blood pH of treated larvae remains normal. Following cessation of feeding, the blood becomes progressively more alkaline, and paralysis of larvae is evident in 60 to 70 minutes. After the larvae have been in paralysis for 10 to 15 minutes the blood pH rises to a maximum. The increase in the alkalinity of the blood is accompanied by a decrease in the pH of the midgut contents. The results of a typical experiment are given in the table below.

Effect of *B. sotto* toxin on the blood pH of silkworm larvae

Time after feeding	Condition of larvae	pH of blood Instar		pH of median midgut Instar	
		4	5	4	5
Start of feeding	Feeding normally	6.4	6.8	10.1	10.3
20-30 min.	Cease feeding	6.4	6.9	—	—
30-45 min.	Sluggish	7.2	7.4	—	—
60-70 min.	Onset of paralysis	7.4	7.7	8.6	9.4
80-85 min.	Paralysis	7.7	8.1	—	—

In studies of anoxia in insects, Gamo *et al.* (5) reported that the blood became more alkaline and suggested that it was the result of "leakage from the gut". A similar process may occur in 'sotto' poisoning, since in paralysed larvae the increase in blood pH is accompanied by a decrease in the pH of the gut.

Whether the increase in blood pH is the immediate cause of the observed paralysis is not known but such a hypothesis is strengthened by the observation that when the pH of fourth-instar silkworm blood is changed to 7.0 by injections of suitable buffers, muscular control is affected. If the blood pH is further increased to 7.5, an irreversible paralysis occurs that ends in death.

Studies of the mode of action are being continued and will be reported in detail later.

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Dolichopodidae (Diptera Brachycera) from Nova Scotia¹

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Collections made during a family vacation trip to Nova Scotia in the latter part of July, 1955, include records of Dolichopodidae which seem worth reporting. The following localities yielded specimens: Parrsboro, July 23, 1955, along river near town; Smiths Cove, near Digby, July 24, 1955, on tidal flats and among vegetation along shore of Annapolis Basin; Antigonish, July 25, 1955, along small creek crossing Route 4 a few miles east of town; South Gut St. Anns (Cape Breton Island), July 27, 1955, in spring seepage area on hillside, with grasses, sedges, alder, sphagnum, orchids, iris, etc. The specimens will be deposited in the Canadian National Collection.

Dolichopus cuprinus Wied. 5 ♂, Antigonish; 20 ♂, Smiths Cove.

D. fulvipes Lw. 1 ♂, Parrsboro; 1 ♂, Smiths Cove.

D. gladius V.D. 14 ♂, 4 ♀, South Gut St. Anns; 1 ♂, Antigonish.

D. indigena V.D. 1 ♂, Parrsboro.

D. marginatus Aldr. 5 ♂, Smiths Cove.

D. melanocerus Lw. 1 ♂, 2 ♀, South Gut St. Anns; 1 ♂, Antigonish.

D. nigricornis Mg. 1 ♀, South Gut St. Anns.

D. pugil Lw. 3 ♂, Smiths Cove.

D. setosus Lw. 2 ♂, South Gut St. Anns.

D. sincerus Mel. 3 ♂, Parrsboro.

D. socius Lw. 6 ♂, Smiths Cove.

D. variabilis Lw. 1 ♂, Antigonish.

D. wheeleri Mel. and Brues. 2 ♂, Parrsboro.

Hercostomus difficilis Lw. 1 ♂, Smiths Cove.

H. nigribarbus Lw. 4 ♂, Parrsboro.

H. subulatus Lw. 1 ♂, Smiths Cove.

Hydrophorus chrysologus Wlk. 3 ♂, Parrsboro.

Laxina nigrofemoratus Wlk. 1 ♂, Smiths Cove.

Nothosympycnus vegetus Wheeler. 1 ♂, Smiths Cove. Although the specimen agrees well with Wheeler's description, the determination must remain doubtful, since the type is from California.

Paraclius claviculatus Lw. 1 ♂, Smiths Cove.

Pelastoneurus lamellatus Lw. 1 ♂, Smiths Cove.

Rhaphium slossonae Jns. 2 ♂, Parrsboro.

R. signifer O.S. 2 ♂, Smiths Cove.

Remarks upon *Dolichopus* species

Besides the morphological distinctness of the forms, evidence that *Dolichopus gladius*, described by Van Duzee as a variety of *D. socius*, is a distinct species

¹This note also constitutes No. 4 in my "Notes on the Genus *Dolichopus*"; v. Bull. Brooklyn Entom. Soc. 33: 193-194 (1938); 37: 62-67 (1942); 42: 34-38 (1947).

may be adduced from the facts that *D. gladius* was the dominant form at St. Anns, while no *D. socius* was taken, and that no *D. gladius* was taken at Smiths Cove, where six specimens of *D. socius* were taken.

I have noted in a number of instances the presence of two or more very closely related species in the same location. Three species, *D. gladius*, *D. melanocerus*, and *D. setosus*, all taken at Smiths Cove, differ chiefly in the development of ciliae on the hind femora and in the color of bristles. Two other forms, *D. pugil* and *D. marginatus*, both taken on the tidal flats at Smiths Cove, are very similar in the male hypopygia and antennae.

A fragmentary observation on the epigamic behavior of *D. cuprinus* was obtained at Smiths Cove. A male of this species was seen hovering over a female with his legs hanging down, the tarsi bunched together.

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